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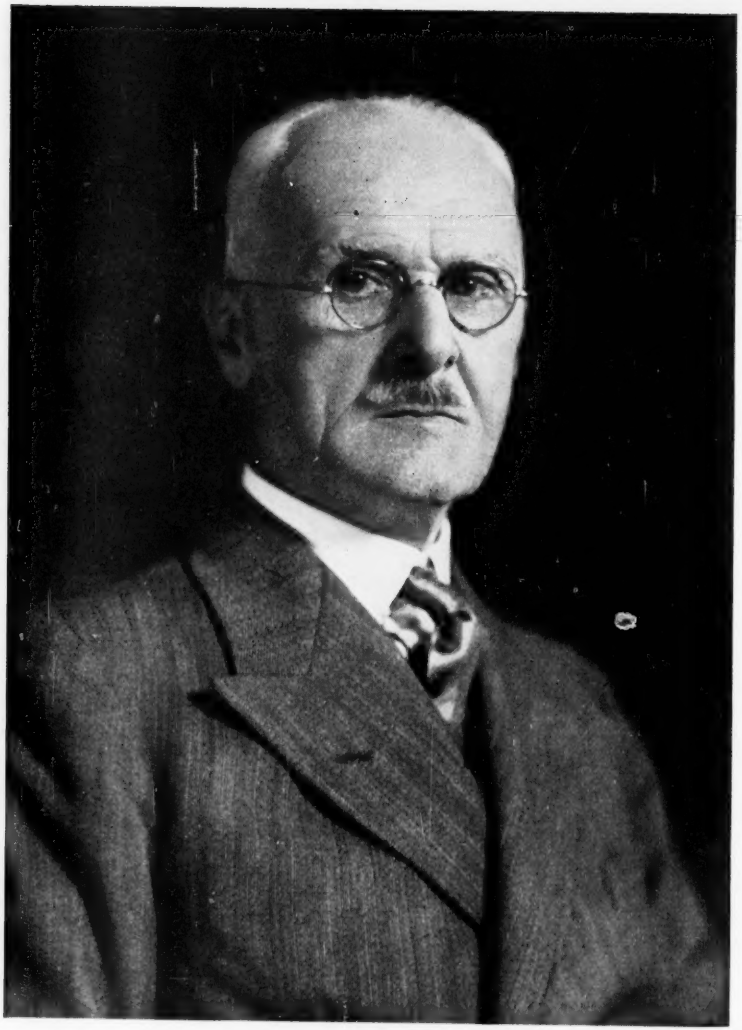

Colonel Frank Wall

Frank Wall, 1868–1950

COLONEL Frank Wall died at his home in Bournmouth on May 19, 1950. He was born at Colombo in 1868. His father, George Wall, an outstanding figure in the political life of Ceylon in the latter half of the last century, was also greatly interested in the natural sciences, and it was from him that his son inherited a love for natural history.

Frank Wall studied medicine at Middlesex Hospital, qualifying in 1892. The following year he entered the Indian Medical Service and, having completed his training at Netley Hospital, went out to India in 1894. There he spent most of the next thirty years of his life and in the course of his duties was stationed in most parts of the Peninsula, including Ceylon and Burma. He saw active service in the first World War and was with the expedition to Mesopotamia. He also served in France. He was twice mentioned in despatches and in 1915 received the C.M.G. for his work at Boulogne.

He retired in 1925 and spent the rest of his life in England, first at Tonbridge in Kent and afterwards at Bournmouth. He was twice married, in 1903 to Margaret Georgina Cusse by whom he had one son, and in 1924 to Mildred Constance Evans who survives him.

Wall's interest in the snakes of India began as soon as he reached that country. In 1895 his name appeared in the list of members of the Bombay Natural History Society and it was in connection with that Society and as a regular contributor to its journal that he came to be recognized as the leading authority in India on the snakes of the country. His first article appeared in 1897, his last in 1925. A complete list of his writings will be found in my volume on the snakes of India and Indo-China (1943) in the fauna of British India series. All together they number 88. Most of his writings consisted of short notes or articles on Indian snakes, dealing with their structure and habits and with taxonomy; but Wall never wrote unless he had a good point to make, and he did not waste words in expressing himself. He took infinite pains to verify his facts, and whatever he recorded is accurate. As a writer he had an easy and lucid style.

His larger works include *The Snakes of Ceylon; The Poisonous Terrestrial Snakes of our British Indian Dominions*, a small volume that ran into four editions; and *A Popular Treatise on the Common Indian Snakes*. This last work, which was published in serial form, is beautifully illustrated in color. It is a great pity that this valuable and interesting series of articles was never brought together and issued in book form.

Wall's attitude toward the study of ophiology was many-sided. He tackled the problem from every point of view, not only observing his species in the field, but dissecting them in an attempt to correlate structure with function, and keeping them in captivity to learn more about their ways and modes of life. Wherever he went, he collected. By offering small rewards to the natives he induced them to hunt for him, and in that way many thousands of snakes passed through his hands. Every specimen was critically

examined. He made careful notes, and it was upon his notes and his excellent memory that he relied for his identifications and for what he published. His collection of skulls, all prepared by himself, is a very complete one. Every genus and every common species is represented, often by several specimens. After his retirement he presented this collection, together with his voluminous notes, to the British Museum (Natural History). To the Museum also came the types of all new species described by him, as well as many other specimens illustrating characters of particular interest.

Wall's work on snakes, although not his interest in them, ended when he left the country. He was not a Museum worker. His one contribution to pure systematics, namely, *A Handlist of the Snakes of the Indian Empire,* was, he told me, the most boring piece of work that he ever undertook. His interest was in the living creatures, and when these were no longer available to him he turned to other activities to occupy his time. But his work in India will not soon be forgotten. It is due to him more than any other man that our knowledge of the habits and distribution of Indian snakes today is so complete.—MALCOLM SMITH, *British Museum (Natural History), London, England.*

Some Aspects of the Life History of the Yucca Night Lizard, *Xantusia vigilis*

MALCOLM R. MILLER

IN THIS paper are summarized data concerning habitat, feeding activity, population, reproductive activity, testicular and ovarian cycles, and size and growth of the viviparous lizard, *Xantusia vigilis* Baird. Described in other papers are the seasonal cycles in testicular and ovarian histology (Miller, 1948a), and the correlation of reproduction and growth with seasonal changes in pituitary cytology (Miller, 1948b). In the course of these investigations 750 specimens were captured and studied. The majority of them were collected in the northern part of the Mojave Desert of southern California.

Xantusia vigilis, commonly known as the Yucca night lizard, is one of four species of the genus *Xantusia* which inhabit parts of central and southern California and northern Lower California. It has been found in several of the southern counties of California, in the northern part of Baja California, in the Pahrump Valley of Nevada (Van Denburgh, 1922), and more recently in the southern part of Utah (Storey, 1940).

Xantusia vigilis is a relatively small lizard. A fully adult female averages 41 mm. in snout-anus length, 80 mm. in total length, and 1.3 g. in weight.

An adult male averages 38 mm. in snout-anus length, 65 mm. in total length, and 1.1 g. in weight. Adult males, besides being lighter and shorter than the females, are characterized by enlarged femoral pores and usually a shorter and fatter tail.

Habitat, Habits and Feeding

The personal experience of the author has been limited to collecting *Xantusia* from the Antelope Valley region of the Mojave Desert. It is not known whether conditions favoring the presence of the lizard in this region are the same as exist in other parts of its range. Consequently, the information concerning the habits of *Xantusia* presented here is based on those individuals inhabiting this portion of the Mojave Desert.

In the Antelope Valley, *Xantusia* is found most commonly in piles of broken limbs of the Joshua tree (*Yucca brevifolia*). Occasionally specimens are found under loose bark, in piles of trash, and, rarely, between loose slabs of rock bordering Joshua tree areas.

In the winter months, the lizards crawl between the sharp-edged imbricated leaves of the fallen limbs, and in order to find the animals, one must hack these limbs to pieces. A medium-sized, sturdy shovel has been found to be the ideal collecting instrument. In the spring and summer, the animals seldom are found between the leaves, lying, rather, between the slowly decaying leaves and the sandy soil. *Xantusia* has never been found to be subterranean in habit, nor does it seek cover in the burrows and retreats of other lizards. No tendency to burrow in the sand of laboratory vivaria has been observed.

Gregariousness is a marked feature in the late fall and winter months, while during the spring, summer, and early fall, seldom more than two or three individuals are found within the limits of an isolated branch or in a small pile of debris. In late November, the animals begin to congregate in piles of debris. During the winter of 1940, when collecting in the Palmdale area, as many as eight to fourteen individuals were taken on several occasions from a single small log. This gregarious tendency extends to late February at which time individuals begin to isolate themselves. Although no direct observational proof is extant, it seems likely that the phenomenon of spring and summer isolation is related to a condition of territoriality.

Studies made during the summer of 1940 revealed that on the hotter days the dry-bulb air temperature was 40-43° C., and the open ground temperature 60-62° C. Under unshaded piles of debris on these days, temperatures of 35-42° C. were recorded, while under shaded piles, the temperature rarely exceeded 35° C. No specimens of *Xantusia* were ever found under piles where the temperature was greater than 35° C. Consequently, during the summer, *Xantusia* is found almost always under shaded piles of debris.

If specimens were kept in containers in which the temperature was permitted to exceed 37° C., the animals succumbed within five to ten minutes. It was found essential for all summer collecting to wrap specimen containers with wet burlap. These observations correlate well with the experimental

data of Cowles and Bogert (1944) who found that the lethal temperature for *Xantusia vigilis* was 38-39° C.

There is definite preference for more moist areas. Where piles of debris have retained moisture from previous rains or the ground is in a drainage area, decomposition of the Joshua wood occurs more rapidly, and insects are more abundant. In such locations, the lizard is found in greatest numbers.

Xantusia vigilis is most abundant in the Fairmont area of the Antelope Valley. In sections of the Joshua forest of this region, the population of *Xantusia* is estimated to be approximately 2,000 individuals per square mile. In especially favorable sections, the population is estimated to be two to three times the above figure. During the winter months, large numbers of individuals may be found in a relatively small area. In the Palmdale Joshua Forest, on November 26, 1940, over 100 were seen, and 87 of these were captured in an area of 75 square yards.

From 1858, when Baird first described *X. vigilis,* until Van Denburgh (1895) published his revision, it was considered to be rare. Van Denburgh's observations revealed it to be the most abundant lizard in the territory chosen for its home. It is the opinion of the author that *Xantusia vigilis* is the most abundant reptile in the Joshua tree areas of the northern part of the Mojave Desert.

Intensive collecting throughout the year in this region has shown that *Xantusia* is an animal with no hibernative period. During the coldest days of December, January, February, and early March, *Xantusia* was found to be almost always somewhat active and to attempt vigorous escapes. Stomach analyses showed that feeding occurs throughout the year. The food supply is less abundant during the winter months, and animals become warm enough to feed only during the middle of the day. On the colder days, specimens collected before ten or eleven in the morning were sluggish, but toward noon, due to warming of the debris by the sun, most individuals had become active enough to run.

During the winter months, feeding occurs during the day, while animals captured during the warmer days of spring and summer appeared to have been resting. Supposedly the greatest activity in spring and summer is nocturnal, when field observations are few; but in laboratory vivaria, *Xantusia* is more active at night.

Analyses of stomach contents show that *Xantusia* feeds primarily on termites, small beetles, collembolids, crickets, moths, or almost any available small insects. Although some feeding activity is carried on throughout the year, food is most abundant in April and May and in September and October. It is significant that these times are coincident with the period of greatest gonadal activity.

Although information concerning possible predators is not at hand, it may be supposed that, because of its secretive habits, few birds or diurnal reptiles would prey upon it. Because, in otherwise well inhabited regions, *Xantusia* is absent in the large piles of debris composing the nests of the wood rat *(Neotoma),* it may be that it is eaten by this rodent. It is possible

that foxes, skunks, and the nightsnake *(Hypsiglena)* may in the course of their nocturnal rummagings have occasion to eat *Xantusia*.

Reproduction

The infrequent occurrence of more than one male and one female under a single small pile of debris in the spring suggests some degree of territoriality. Studies during the spring and summer of 1940 and 1941 showed that the sperm began to pass from the seminiferous tubules into the epididymides and vasa deferentia about the middle of May. Although observations of mating behavior have never been made, copulation was known to occur sometime during the last week of May and the first week of June. All of the females captured in 1940 ovulated between the first and the tenth of June, while in 1941, probably due to heavy spring rains, maturation of ova was delayed and ovulation occurred from the second week in June until the second week in July. All of the males in 1941 showed, by the collapse of the seminiferous tubules and the regression of the vasa deferentia, that copulation had occurred sometime between the first and the eighteenth of June. Observations made during the summer of 1950 indicated that ovulation occurred during the second and third weeks of June. It seems likely from studies of the ovary, testis, and secondary sex ducts, that copulation occurs approximately one to two weeks previous to ovulation, but may precede it by as much as four weeks.

The testis is minimally active during late June and July. By early August the new spermatogenetic cycle begins, and in September, spermatogonial activity is of considerable extent. This activity slows down during October, and a winter minimum is established which extends into March. Then, spermiogenic activity gradually accelerates and becomes maximum in April and May. Spermatogenesis occurs primarily in the fall and spermiogenesis in the spring. Males become sexually mature when two years of age. A detailed description and discussion of the testicular cycle is presented in another publication (Miller, 1948a).

Females are sexually mature at three years of age. An ovum requires three years for complete development (Miller 1948a), and two years are required for one to attain a diameter of 1.0-1.2 mm. In the spring of the third year, usually the largest ovum in each ovary undergoes rapid enlargement due to yolk deposition, and attains a diameter of 6 to 7 mm. In the majority of individuals one ovum is ovulated from each ovary, and one embryo develops in each oviduct.

Of 78 gravid females studied during the summers of 1940 and 1941, 60 (76.9%) carried two embryos; 17 (22%) carried one embryo; and 1 (1.1%) carried three. Of the 60 carrying two, 59 had one embryo in each oviduct and 1 had two embryos in the right; of the 17 animals carrying a single embryo, all were gravid in the right oviduct only. The single specimen with three embryos had two in the right and one in the left oviduct.

A corpus luteum develops from each ovulated follicle. This structure is fully developed by the second week after ovulation, and remains fully de-

veloped and apparently functional until three to four weeks before parturition when degeneration begins.

The number of corpora lutea is always the same as the number of developing embryos. Of the 59 females carrying an embryo in each oviduct, 32 (53.3%) had a corpus luteum in each ovary, 20 (33.9%) had two corpora in the right, and 7 (11.5%) had two corpora in the left ovary. Of the 17 animals gravid with one embryo, always in the right oviduct, 13 (or 76.5%) had a single corpus in the right ovary, and 4 (23.5%) had it in the left. The animal with two embryos in the right oviduct and one in the left had three corpora in the right ovary.

Sections through the entire intact ovum and embryo in the oviduct show that a thin shell membrane is first deposited, but this soon disintegrates and collects as a small mass of degenerated material lying between the ventral anterior surface of the ovum and the oviducal wall. Within a few weeks, a chorio-allantoic placenta of a non-interdigitating simple type is formed which lies in intimate contact with the thin glandular wall of the oviduct.

Since the average mass of the ovum at ovulation is 0.115 g., and that of the newly born young is 0.230 g., it follows that half the total body weight of the completely developed animal is derived from materials transported across the oviducal wall to the simple placenta.

The length of the gestation period is approximately three months. In 1940 when the great majority of the females ovulated during the first ten days of June, almost all of the young were born during the first ten days of September. During 1941, ovulations were spread from the middle of June to the middle of July, and it was observed that females were giving birth to young from mid-September to mid-October.

In regard to the length of gestation in lacertilians, Weekes (1934) found that the average gestation period for several species of viviparous Australian lizards is approximately three months; and Boyd (1940) found the same true for the viviparous New Zealand Gecko, *Hoplodactylus*. Cowles (1944) described the process of parturition in *Xantusia*.

Size and Growth

Three hundred and fifty specimens of *Xantusia vigilis*, captured over the period from August 5, 1940 to August 20, 1941, were measured and weighed, and from these data it is possible to draw some conclusions as to the probable growth rate.

It was found that the snout-anus length was a more reliable criterion of growth than total length, because of considerable variability in the tail. Likewise, differences in tail lengths and stomach contents made total body weight a less reliable index of growth than snout-anus length. Consequently, the rate of growth for the first three years of life (Fig. 1) is based on snout-anus lengths.

Newly born animals vary in snout-anus length from 22-24 mm., averaging 23 mm., and weigh an average of 0.23 g. Growth is slow throughout the year, but more rapid during the spring when the food supply is more

abundant. One-year-old animals average 29 mm. in snout-anus length and 0.40 g. in weight.

At the age of two years, an average snout-anus length of 36 mm. and a weight of 0.70 g. are attained. Males of this age are sexually mature. Females do not become mature before a snout-anus length of 38-39 mm. is reached.

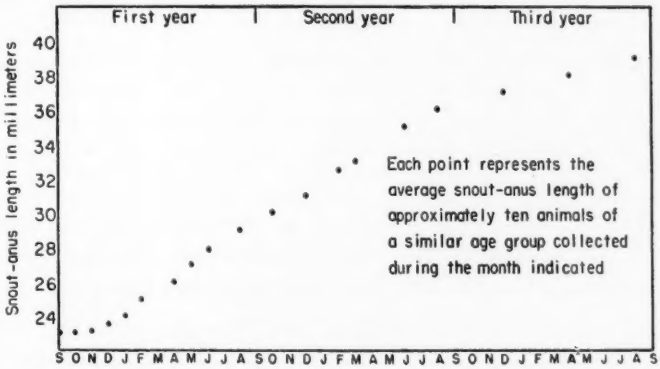
First year
Second year
Third year
Snout-anus length in millimeters
40
38
36
34
32
30
28
26
24
Each point represents the average snout-anus length of approximately ten animals of a similar age group collected during the month indicated
S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S

Fig. 1. Growth rate of *Xantusia vigilis* during the first three years of life.

A study of the ovarian cycle shows that a female must be at least three years old before sexual maturity is achieved. This is also true of the skink *Eumeces septentrionalis septentrionalis* (Breckenridge, 1943).

At the age of three years, a snout-anus length of 38-39 mm. and a weight of 0.9-1.0 g. are attained. After the third year, gross data of this nature do not reveal the growth rate of sexually mature animals; however, females become larger than males and usually average 0.20 g. (16%) more in weight and 3 to 4 mm. more in snout-anus length.

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Variation, Life History, and Taxonomic Status of the Fukien Green Pondfrog, *Rana fukienensis* Pope

HAN-PO TING

IN 1925, Pope collected a number of frogs from Futsing Hsien and Ch'ungan Hsien, Fukien, China, that had some characteristics of *Rana nigromaculata* and some of *Rana plancyi*. He described these frogs as *Rana fukienensis* (Pope, 1929). It was really long before that, however, that Stejneger (1907) had observed that the five specimens in the British Museum labelled *Rana plancyi* from Taiwan (Formosa) do not have the dorso-lateral fold as broad as do specimens from Shanghai. He noted that the vomerine teeth are more anterior in position than in Shanghai specimens, and that four of the five specimens from Taiwan have a very distinct mid-dorsal line. He also stated that the inner metatarsal tubercle varies in size. Later (1925), he stated that the differences between specimens from Taiwan and Shanghai do not hold and are of a purely individual character.

Pope (1931) compared his Fukien specimens of *R. fukienensis* with those of *R. plancyi* from Shantung and Anhwei, and found that the former have a shorter and lower metatarsal tubercle, a longer leg, more variable dorso-lateral folds, and less variable coloration. He felt that material from intermediate territory might very possibly demonstrate complete intergradation.

From studies of large numbers of *R. plancyi* from various provinces of China, such as Hopei, Kiangsu, Anhwei, Chekiang, Kiangsi, and Hupeh, and of *R. fukienensis* from Fukien, Boring and Chang (1933, 1934, 1936, 1938) found that there is a great amount of variation. The tibia length of Fukien individuals is greater than that of specimens from other places. The ratio of metatarsal tubercle length to inner toe length gradually increases from south to north (about ½ for Foochow, ⅗ for Ningpo, ⅗ for Wuhu, ⅘ for Nanking, and 1¼ for Peking specimens). The frequency of occurrence of a mid-dorsal line increases gradually from Soochow toward Amoy. The thigh is more or less mottled in specimens from south of the Yangtze River.

Dorso-lateral folds are generally narrower in specimens from Ningpo southward. Finally, Peking specimens are dorsally bright green and ventrally yellow, while those from Foochow are dorsally brown and ventrally white with yellowish striations. There is also individual variation in certain characters. The ventral color of Wenling (Chekiang) samples varies from almost white to deep yellow. Some have wide dorso-lateral folds, and some have narrow ones; only one among 114 has a clear mid-dorsal line. The specimens from Peking show variation in the extent of the yellow coloration of the ventral side, the degree of mottling of the thighs, and the width of the dorso-lateral folds. Boring (1938) concluded that *R. plancyi* of the north and *R. fukienensis* of southern China are subspecies of the same species.

In view of the fact that only preserved adults of *R. fukienensis* were studied by most of the previous writers, a careful study of living adults, as well as tadpoles, was made when the writer held a teaching position in Fukien. Specimens from different localities in Fukien were collected and carefully compared.

Description of Adults

Figs. 1–6

Because Pope's original description (1929) is based mainly on preserved specimens, some of the characters described by him are different from those observed in the living frogs. In order to avoid duplication, the writer here mentions only a few important characters.

Coloration. (a) Shaowu specimens. In life, olive green above with greenish yellow mid-dorsal line; ventral side, light golden yellow. In formalin, grayish brown above; very light yellow on ventral side; more yellow on the border of chin, sides of throat and chest, and groin. Of 26 specimens, seven have mottling on ventral side. Thigh stripes not so conspicuous as those of *R. plancyi* from Peking, but thigh mottling more definite.

(b) Ch'ungan, Shunanch'ang, and Shahsien specimens. Coloration like that of Shaowu specimens. No mottling on ventral side. Thigh stripes not so conspicuous as those of Peking specimens; thigh mottling very definite.

(c) Foochow specimens. In life, dorsal color varies from yellowish green to dark brown; mid-dorsal line greenish gray; ventral side light golden yellow. In formalin, grayish brown above, whitish below, but yellowish at sides of throat and chest, and at groin. Of 40 specimens, 28 have mottling on ventral side. Some thigh stripes as conspicuous as those of Peking specimens. Thigh mottling very definite.

Mid-dorsal line. Of 31 specimens (13 females, 18 males) from Shaowu, all except one male have a mid-dorsal line, although in some specimens the line is very faint. In 12 from Shuanch'ang (2 male and 2 female adults, 8 young), 3 from Ch'ungan (2 females, 1 male), and one male from Shahsien, the mid-dorsal line is present. Among 40 specimens (39 females, 1 male) from Foochow, only 25 (24 females, 1 male) have a mid-dorsal line.

Vocal sacs. All the males from the various localities have poorly developed external vocal sacs below the angles of the jaws, and two round

vocal sac openings. The smallest individual showing vocal sacs is one from Shuanch'ang with a body length of only 36.4 mm.

Body measurements. There are no conspicuous differences in the major morphological characters of specimens from different localities in Fukien (Table I). However, there are several aspects in which *R. fukienensis* differs markedly from *R. plancyi* from Peking. The head of *R. fukienensis* is almost as long as wide; in *R. plancyi,* the head is wider than long. The ratio of metatarsal tubercle length to inner toe length is about 0.5 in *R. fukienensis,* while in *R. plancyi* it is about 0.9. The hind leg of female *R. fukienensis* is a little longer than that of *R. plancyi.* The dorso-lateral folds of *R. fukienensis* are narrower than those of *R. plancyi.* The dorso-lateral folds in most of the preserved specimens of *R. fukienensis* are high and conspicuous, but in some are quite flat. In the living individuals, they are conspicuous and look even wider than those of the preserved specimens. The dorso-lateral folds of seven living female specimens (average body length, 60.6 mm.) from Foochow have an average width of 3.33 mm., and the ratio to body length is 0.056. Although this value is greater than that of the preserved specimens, it still differs significantly from that of *R. plancyi.*

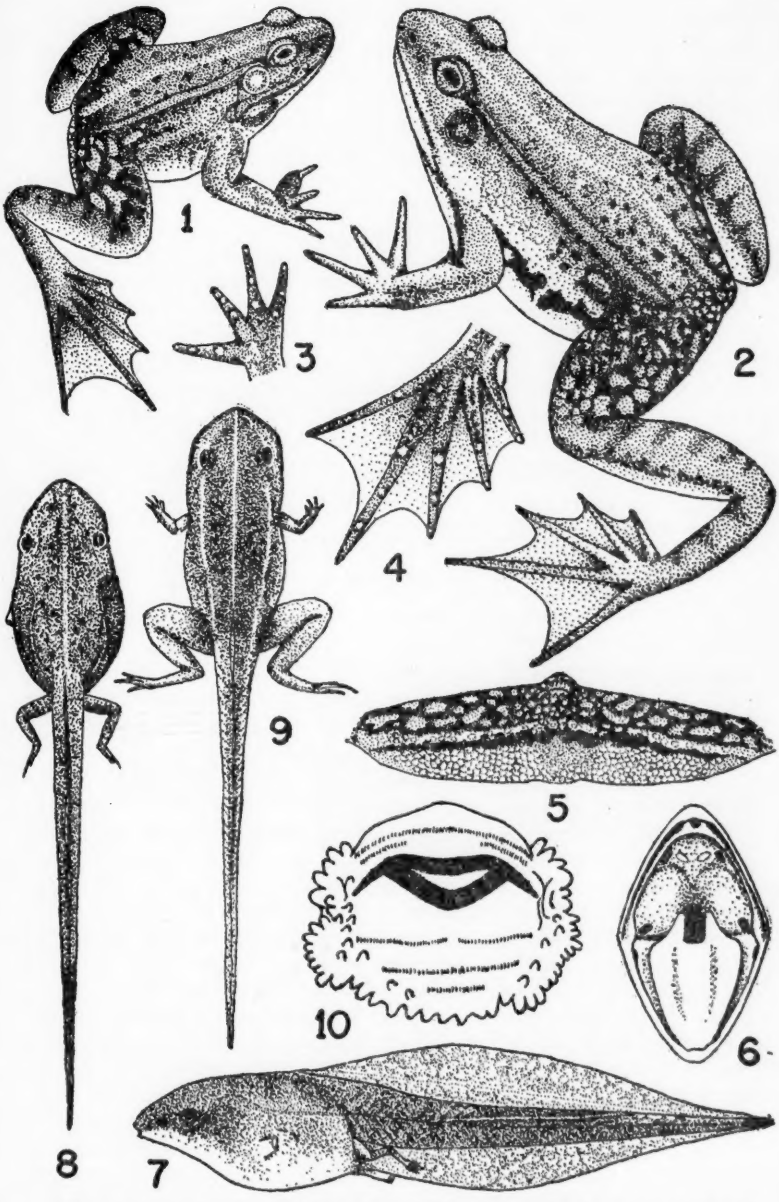
Description of Shaowu Tadpoles
Figs. 7–10

Nostrils equidistant from tip of snout and eyes; internasal distance about half the interorbital; mouth antero-ventral in position; spiraculum sinistral, slightly nearer eye than origin of hind leg; vent dextral, with orifice on margin of ventral tail crest and apart from body; upper tail crest with conspicuous lines of muciferous crypts; tail crests wide, upper wider than lower; lips resemble those of *R. nigromaculata,* but not so outwardly flared; continuous row of papillae on two sides of upper lip and on lower lip; few scattered papillae at corners of mouth and on sides of lower lips; tooth formula variable; at least nine types of tooth formulae (Fig. 11). Greenish brown on back, mottled with small dark gray spots; belly light golden yellow; a dark spot in front of eye; no mid-dorsal line in tadpoles until hind legs are about 13 mm. in length. Total length, 25.8 – 56.5 mm.; body length, 9.2 – 18.0 mm.; hind leg length, 0.7 – 23.5 mm. Two newly metamorphosed young had the following measurements: body length, 18.5 – 19.8 mm.; hind leg length, 29.6 – 30.5 mm.; foreleg length, 9.4 – 10.5 mm.

Habitat, Life History, and Geographical Distribution in Fukien

These frogs live on plains or plateaus in ponds or rice fields with floating water plants. They usually sit on the banks or on the large green leaves floating on the surface of the water. When disturbed, they jump into the water, and, instead of hiding in the mud, swim for a short distance and then emerge again. Thus there is no difficulty in finding them.

In Shaowu, the breeding season is in late April and May. Croaking has not been heard by the writer. This may be due to the fact that the male possesses only poorly developed external vocal sacs. However, on some occasions a sound like the clapping of hands was produced by males jumping into the water upon being disturbed. The eggs, like those of *R. plancyi,* are



Figs. 1–10. *Rana plancyi fukienensis.* 1. Male (approximately x 1). 2. Female (approximately x 1). 3. Underside of left hand of female. 4. Underside of left foot. 5. Back of thighs. 6. Mouth cavity. 7–9. Tadpoles, different stages (approximately x 2). 10. Tadpole mouthparts.

brownish at the animal pole, and light yellowish at the vegetal pole. The duration of the tadpole stage is about two months. Metamorphosis has been observed as early as the middle of June.

Rana fukienensis has been collected from Ch'ungan, Shaowu, Shuanch'ang, Foochow, Futsing, Shahsien and Amoy. There are no records from southwest Fukien or from south of Amoy. It is distributed, therefore, from northern Fukien southward only to Amoy in the eastern part, and to the midwestern portion of the province.

Discussion

There are no conspicuous differences between specimens of *R. fukienensis* from various localities in Fukien. However, the following characteristics differentiate it from *R. plancyi* of Peking: narrower dorso-lateral folds, a slightly narrower head, smaller ratio value of metatarsal tubercle length to inner toe length, longer hind legs in females, smaller external vocal sacs in males, a mid-dorsal line in some individuals, more conspicuous thigh mottling, and less yellowish coloration on ventral side of the body. There are also certain characters found in tadpoles of *R. fukienensis* which are different from those of *R. plancyi:* the two lips slightly flared at the sides, variable

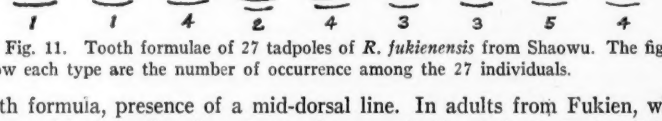


Fig. 11. Tooth formulae of 27 tadpoles of *R. fukienensis* from Shaowu. The figures below each type are the number of occurrence among the 27 individuals.

tooth formula, presence of a mid-dorsal line. In adults from Fukien, when preserved in formalin, the color on the ventral side of the body faded from golden yellowish to slightly yellowish, or even whitish; in Peking specimens, similarly preserved, the yellow color was retained.

Now the question arises as to whether the Fukien green pondfrog is to be regarded as a separate species as Pope first described it, or simply a variety of *R. plancyi.* Dobzhansky (1941) defined species as "that stage of evolutionary process at which the once actually or potentially interbreeding array of forms becomes segregated in two or more separate arrays which are physiologically incapable of interbreeding." If this definition is accepted, then hybridization and breeding experiments both in nature and in the laboratory should be performed with frogs from Fukien and from the neighboring provinces as well as from central and northern China. Moore (1946, 1947) performed a series of hybridization experiments on the leopardfrog, *Rana pipiens,* from different regions of the United States and eastern México. He found that the farther apart the origin of two forms, the greater was the degree of abnormality in the hybrids. The cross of *R. pipiens* from Vermont with specimens from Texas or México produced hybrid embryos which lived for only a short period. Moore contended that if there were no intermediate population, the *R. pipiens* complex might be divided into two distinct species, a northern and a southern. Wright and Wright (1949) recognized six subspecies of *R. pipiens* occurring in the United States.

Table I

Average Measurements (in mm.) and Proportions of Preserved Specimens of *R. fukienensis* from Different Localities in Fukien, and of *R. plancyi* from Peking

TABLE I

AVERAGE MEASUREMENTS (IN MM.) AND PROPORTIONS OF PRESERVED SPECIMENS OF *R. fukienensis* FROM DIFFERENT LOCALITIES IN FUKIEN, AND OF *R. plancyi* FROM PEKING

Locality	Shaowu		Foochow		Ch'ungan		Shuanch'ang		Shahsien	Peking (*R. plancyi*)	
Number of specimens measured, and sex	11 males	11 females	1 male	26 females	1 male	1 female	2 males	2 females	1 male	1 male	3 females
Body length (snout to vent)	42.9	61.2	48.3	65.4	38.0	50.4	40.4	56.6	45.7	45.3	62.2
Width of head (at angle of jaws)	15.2	21.0	16.3	21.3	14.7	17.3	14.3	18.7	16.3	17.4	21.7
Length of head (perpendicular dist. from snout to post. rim of tympanum)	15.3	19.7	17.2	21.6	14.8	17.4	14.6	17.5	16.3	15.5	18.9
Width of tympanum	4.5	5.3	4.2	5.7	3.6	3.8	3.6	4.0	4.9	5.2	5.3
Nostril to tympanum	9.3	13.2	10.0	14.2	8.8	10.8	8.8	12.1	9.5	9.5	13.3
Internasal distance	3.5	4.4	3.7	4.5	3.5	3.8	2.9	4.2	3.8	3.2	3.9
Length of foreleg (to tip of longest finger)	24.0	34.1	28.1	36.2	22.7	28.6	23.4	31.6	24.0	26.5	34.3
Length of upper arm	8.3	11.1	10.2	11.3	9.4	9.2	8.3	10.8	8.8	8.2	10.8
Length of hindleg (vent to tip of longest toe)	70.1	102.5	75.0	103.9	65.8	76.2	64.0	87.7	73.0	72.0	93.0
Length of tibia	20.5	29.7	23.8	30.0	20.3	24.3	19.0	25.9	22.8	20.6	26.1
Length of foot (post. border of metatarsal tubercle to tip of longest toe)	24.6	35.2	26.0	36.2	23.6	27.5	21.7	30.0	25.8	28.3	33.8
Length of inner toe (from outer base of metatarsal tubercle to its extremity)	6.1	8.4	6.4	8.5	5.5	5.8	5.5	7.1	6.2	5.0	6.4
Length of inner metatarsal tubercle	2.6	3.7	3.8	4.2	2.3	2.8	2.0	3.1	2.9	4.5	5.6
Width of dorso-lateral fold (at middle region)	1.5	2.7	3.1	2.6	1.6	2.1	1.4	2.3	2.0	3.3	4.7
Width of head/length of head	0.99	1.06	0.95	0.99	0.99	0.99	0.98	1.07	1.00	1.12	1.14
Foreleg/body length	0.56	0.56	0.58	0.55	0.60	0.57	0.58	0.56	0.53	0.58	0.55
Hindleg/body length	1.63	1.67	1.55	1.59	1.73	1.51	1.58	1.55	1.60	1.59	1.49
Tibia/body length	0.48	0.49	0.49	0.46	0.53	0.48	0.47	0.46	0.50	0.45	0.42
Metatarsal tubercle/inner toe	0.43	0.45	0.59	0.50	0.42	0.48	0.36	0.44	0.47	0.90	0.88
Dorsolateral fold/body length	0.036	0.044	0.064	0.040	0.042	0.042	0.035	0.041	0.044	0.073	0.075

So far, no hybridization experiment has been carried out involving *R. fukienensis* and *R. plancyi*. However, crosses have been made between *R. plancyi* and *R. nigromaculata*, both species from Peking (Ting, 1939, 1948), and between *R. fukienensis* and *R. nigromaculata*, both from Fukien (Ting, unpublished). The hybrids from both crosses developed into healthy frogs, and it is very probable that, if *R. fukienensis* is crossed with *R. plancyi*, viable hybrids will result.

Until further experimental studies are made, it seems desirable to follow the method used in classifying the American leopardfrog, *R. pipiens*. Thus, the writer accepts Boring's (1938) suggestion that the Fukien green pondfrog be recognized as *Rana plancyi fukienensis*.

The writer wishes to express his gratitude to Professor Alice M. Boring of Yenching University, Peking, China, for her critical reading of this manuscript.

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Ontogenetic Changes in Osteodermal Ornamentation in Skinks

JAMES A. OLIVER

IN THE taxonomic literature on lizards there are several systematic studies in which the nature of the ornamentation of the osteodermal plates has been employed. Camp (1923) summarized the available information on these bony dermal plates that lie beneath the horny scales. More recently, Grant (1944) has reported his observations on the osteoderms of the West Indian lizards of the genus *Celestus*. One difficulty in the taxonomic use of these structures is that intraspecific and interspecific variation has not been thoroughly analyzed and is at present little known. The two investigators mentioned above, as well as others, have demonstrated the marked amount of variation that may occur in the ornamentation on the osteoderms from different parts of the body of the same individual. This indicates the

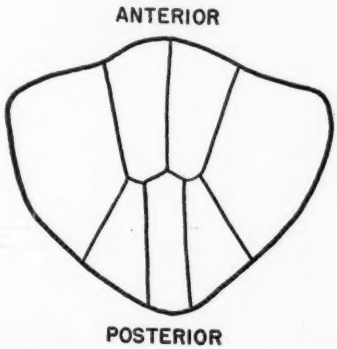

Fig. 1. Main osteodermal ornamentation on plate from anterior middorsal body region of *Eumeces laticeps*.

necessity of using osteoderms removed from the same region of the body if valid comparable results are to be obtained. The present paper calls attention to another type of individual variation that has not been previously noted for this character: variation in the osteodermal ornamentation in relation to size of the individual lizard.

During the course of an examination of some skinks in the collections of the American Museum of Natural History, marked differences in osteodermal ornamentation were observed among different individuals from a homogeneous sample. In order to evaluate these differences, a detailed study was made on a series of thirty specimens of the North American skink *Eumeces laticeps* Schneider from southern Illinois. In this species the main ornamentation on the osteoderms from the anterior middorsal region of

the body consists of a few posterior radii (= canals or tubules?) and a lesser number of anterior radii, all united in the center of the plate by a short, zigzag, transverse connection (Fig. 1). Five osteoderms were removed from the anterior middorsal region of the body of each specimen. The numbers of anterior and posterior radii were recorded for each of the five plates, along with the sex and head-body length of the lizard. The ornamentation on the osteoderms can be observed with a hand lens, but a binocular microscope reveals a greater amount of detail and makes the examination easier.

TABLE I

FREQUENCY DISTRIBUTION OF THE NUMBER OF POSTERIOR RADII ON OSTEODERMS AS RELATED TO HEAD-BODY LENGTH OF 30 SPECIMENS OF *Eumeces laticeps*, 5 OSTEODERMS PER SPECIMEN

Head-body length (mm.)	Number of posterior radii						
	0	Faint indication	III	IV	V	VI	VII
26	5						
31	5						
32	5						
33	5						
35	5						
36	5						
47		5		4	1		
49		5					
62				3	2		
64			3	2			
65				4	1		
68				4	1		
69				2	3		
70				7	3		
72				3	2		
74					5		
75				4	1		
79				4	1		
80				6	4		
81				1	3	1	
84				1	3	1	
94				2	2	1	
101					5		
105					4	1	
115					5	4	1
120					2	3	

Analysis of the data obtained indicates no sexual differences in respect to the ornamentation of the osteoderms. In regard to number, the anterior radii exhibit little variation once they are developed. On the other hand, there is a positive correlation between the number of posterior radii on the osteoderms and the head-body length of the lizard. The correlation co-

efficient for these data is +0.84 (Table I and Fig. 2). (Arnold B. Grobman generously helped with some of these calculations.)

The correlation shown is doubtless an expression of the relationship between the number of posterior radii present and the size of the osteoderm: larger lizards have larger osteoderms and hence more radii. The size of the individual osteoderms was not recorded in the original study, but examination of these plates from the same body region of lizards of different sizes

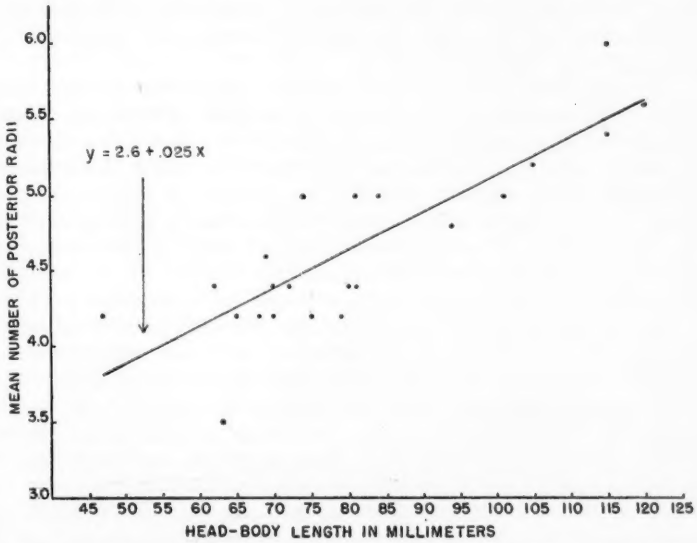

Fig. 2. Relationship between mean number of posterior radii on osteoderms and head-body length of lizard from which the osteoderms have been removed, with line of best fit by least squares. (The formula for computing this line is $y = a + bx$.)

clearly demonstrates that larger lizards do have larger osteoderms than do smaller lizards. In *Eumeces* the number of osteoderms present is constant throughout life.

Six of the lizards examined showed no ornamentation whatsoever on the osteoderms. These lizards varied from 26 to 36 mm. in head-body length. The two largest of these, with head-body lengths of 35 and 36 mm., were animals that had been hatched and raised in the laboratory. They were killed at an age of six months. Two other lizards, with head-body lengths of 47 and 49 mm., exhibited faint suggestions of radii but these were not sufficiently distinct to permit an accurate count. These two lizards were also reared in the laboratory and had been killed at an age of 7 and 10 months, respectively. None of this group of eight lizards was used in the computations. The smallest lizard in which radii can be counted has a head-body length of 47 mm. (Fig. 2). This size is similar to that of the

two largest laboratory-reared lizards in which only a faint indication of radii can be observed, and it is probably the approximate minimum size at which radii become discernible.

The data clearly demonstrate an ontogenetic variation in the character of the osteodermal ornamentation, at least in the species studied, if, as seems obvious, increase in size accompanies increase in age. Small series of other species of *Eumeces*, as well as representatives of three additional genera of skinks *(Emoia, Mabuya* and *Scincus)*, have been examined casually in this regard. While the data are not sufficient to demonstrate ontogenetic variation definitely for all of these, the specimens observed all support the relationship noted in *Eumeces laticeps*.

This ontogenetic variation observed in *E. laticeps* may afford a useful means of determining the approximate age of skinks in life-history studies. As indicated above, in this species, lizards six months of age or under do not exhibit radii. These marks seem to become apparent at about seven to ten months of age, when the animals have a head-body length of approximately 48 mm. Careful analysis of local populations in relation to growth rate, size groups and corresponding osteodermal ornamentation might form the basis for fairly reliable age indication.

The increase in the number of posterior radii as the size of the osteoderm increases appears to be the result of a simple physical response to a greater surface area. Thus changes in the number of radii occur only with actual increase in size of the osteoderm. This is different from the condition found in the bony scales of fishes where the number of annuli varies according to the amount of overall growth activity that has occurred during the different growing seasons. As an indicator of allometric growth in these lizards, the number of radii should be valuable because it varies with the size of the osteoderm. This correlation doubtless accounts for the observed differences in the ornamentation of osteoderms from different parts of the body of an individual lizard.

Summary

Ontogenetic variation in osteodermal ornamentation is demonstrated for the North American skink *Eumeces laticeps* Schneider. If the character of the osteoderms is to be used in the systematics of lizards, ontogenetic variation must be carefully considered. This same variation may provide a useful means of age determination and an indicator of allometric growth in skinks and other lizards that possess bony dermal plates.

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A Proposed Method of Expressing Scale Reductions in Snakes

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THE USE of scale reduction formulae, introduced by Ruthven (1908) and revised and expanded by Schmidt and Davis (1941) and Clark and Inger (1942), has aided greatly in the study of variation in snakes and has been used by numerous subsequent workers. Many workers, however, have made changes in the original form, and some of the changes are of such magnitude that the results are not strictly comparable. For this reason I believe that the time is right for proposing a standard system of notation which combines the advantages of the various forms and does away with most of their disadvantages.

The significance of using detailed dorsal counts, with particular attention to the scale rows which are added and dropped, was first pointed out by Ruthven (1908: 16-21) in gartersnakes. Thompson (1914: 384) indicated, in the form of a table, the point of loss of dorsal rows by reference to the ventral count opposite the drop. Later, Blanchard (1921: 9-13) initiated an abbreviated form of notation

(e.g., 23—21—19)
6 5

which showed the dorsal counts and the scale rows involved in reduction. Ortenburger (1928: 9) carried this somewhat further by showing the observed variation and putting the dorsal counts in boldface type.

The first, however, to effect the advantages of using a concise form of notation that indicated both the dorsal row involved and the position of the reduction or addition was a group of workers at the Chicago Natural History Museum. Schmidt and Davis gave an example of this form of notation in their "Field Book of Snakes" (1941: 28); and the following year Clark and Inger (1942: 163), of the same institution, used this method of presentation in a study of scale reductions in several colubrid genera. These and the subsequent systems derived from them are discussed below.

The system as introduced by Schmidt and Davis (1941: 28) is as follows:

$$21\ \left[\begin{matrix}8\\ \overline{4}\\ 8\end{matrix}\right]\ 19\ \left[\begin{matrix}14\\ \overline{3+4}\\ 12\end{matrix}\right]\ 17\ \left[\begin{matrix}118\\ \overline{3+4}\\ 120\end{matrix}\right]\ 15\ \begin{matrix}[8]\\ 130\end{matrix}\ 14\ \begin{matrix}150\\ [7+7]\\ 150\end{matrix}\ 13$$

The first number and all of those in the midline outside of brackets indicate the dorsal counts obtained at different points on the body from front to rear; the numbers within the brackets are the scale rows involved in the reductions. The numbers above the brackets indicate the ventral count at the point of reduction on the left side of the body; the lower numbers, on the right side.

Although, as previously stated, this system is a great improvement over preceding ones, it has the following disadvantages: (1) the total ventral number is not given; (2) the orientation of the numbers is illogical, for, assuming the head of a snake to be to the left, the upper numbers should refer to the *right* side of the body; (3) only reductions are considered; (4) the formula is widely spaced and takes up *four* lines of type for a single line of formula.

Under the Clark and Inger system, snake scale formulae appeared as follows:

$$19\ \begin{matrix}16\\(3+4)\\\dots\\3+4)\\13\end{matrix}\quad 17\ \begin{matrix}123\\(3+4)\\\dots\\3+4)\\123\end{matrix}\quad 15\ \begin{matrix}\\(8\dots\\+7)\\142\end{matrix}\quad 14\ \begin{matrix}160\\(7+7)\\160\end{matrix}\quad 13\ \begin{matrix}197\\\\197\end{matrix}$$

showing vertebral and paravertebral fusion, and,

$$21\ \begin{matrix}6\\(3+4)\\\dots\\4+5)\\7\end{matrix}\quad 19\ \begin{matrix}10\\(3+4)\\\dots\\3+4)\\10\end{matrix}\quad 17\ \begin{matrix}44\\(3=3+4)\\\dots\\3=3+4)\\44\end{matrix}\quad 19\ \begin{matrix}118\\(4\\\dots\\5)\\117\end{matrix}\quad 17\ \begin{matrix}135\\(2+3)\\\dots\\2+3)\\136\end{matrix}\quad 15\ \begin{matrix}203\\\\203\end{matrix}$$

showing the addition of a scale row. The general plan is the same as the Schmidt and Davis system but the orientation has been corrected; the upper figures refer to the *right* side of the snake. The problem of representing the addition of rows has been solved by the symbol "3 = 3+4," which means that the third row has split to form the third and fourth *or* that a fourth row has been added above the third. Also, the total ventral number is given at the end of the formula. But with these advantages there are the following disadvantages: (1) the method of showing additions of scale rows is cumbersome; (2) the formula is widely spread, taking up five lines of type for each line of formula. Nevertheless, this has been the basic system adopted and has been used with only slight modification by Burger (1950: 65), Flury (1950: 215), and others.

Somewhat more modified was the system that I used (1950: 8) which appeared as follows:

$$17-17\ \frac{-4(76)}{-4(79)}\ 15(120)$$

The dropping of the fourth row is shown merely by "−4," with the ventral counts in parentheses. This type of formula is much more compact and takes up only two lines of type for each line of formula. It, however, suffers from two possible defects: (1) in longer formulae the dorsal counts may not be sufficiently differentiated from the other numbers for easy reading; (2) the formula is somewhat more elongated than the Clark and Inger type.

Each of these systems has added to the usefulness and ease of presentation of this otherwise almost unmanageable kind of data. A standard method of presentation, combining the advantages outlined and attempting

to do away with their disadvantages, appears as follows:

$$\mathbf{19}\ \frac{3+4(16)}{3+4(13)}\ \mathbf{17}\ \frac{3+4(123)}{3+4(123)}\ \mathbf{15}\ \frac{8}{+7(142)}\ \mathbf{14}\ \frac{7}{+7(160)}\ \mathbf{13}\ (197)$$

and,

$$\mathbf{21}\ \frac{3+4(6)}{4+5(7)}\ \mathbf{19}\ \frac{3+4(10)}{3+4(10)}\ \mathbf{17}\ \frac{+4(44)}{+4(44)}\ \mathbf{19}\ \frac{-4(118)}{-5(117)}\ \mathbf{17}\ \frac{2+3(135)}{2+3(136)}\ \mathbf{15}\ (203)$$

The orientation is the same as in the Clark and Inger system, the upper figures referring to the right side of the snake. The addition of a scale row is shown merely by a plus sign and the number of the row. Where a scale row actually splits, there may be occasion to use the same symbol ($4 = 4+5$) as in the Clark and Inger system, but this appears to occur only infrequently. Reductions are shown by a minus sign and the row number when a row is lost, and by the plus symbol ("3+4," etc.) when two rows join. To avoid possible confusion, only the dorsal counts are placed on the midline (with the exception of the total ventral number at the end), and they are in boldface type for easy reading. The ventral counts are placed in parentheses following the scale numbers, thus saving two lines of type per line of formula.

The question of using Roman numerals to designate the scale rows involved in the reductions was considered. This system has been used by numerous workers (Thompson, 1914: 384; Oliver, 1948: 178; etc.) and has the advantage of differentiating these from other numbers in the formula or text. In formulae, however, it has the disadvantage of becoming unwieldy with large numbers, and uses two times or more the space that a system using Arabic numerals does. I believe that these disadvantages outweigh any advantage of differentiation gained by the use of Roman numerals in formulae, although it is a useful method of differentiation when used in text.

The above method of presenting scale reductions is based primarily on the formulae of Clark and Inger, and subsequent modifications, and is proposed as a standard system of notation. Dorsal scale variation has been shown to be highly characteristic in the few genera and species of snakes in which it has been studied, but, to date, detailed formulae have not been widely used in snake taxonomy. It is hoped that standardization of the method of notation may encourage greater usage.

I wish to express my thanks to Drs. Norman Hartweg and Charles F. Walker of this institution, and to Mr. Philip J. Clark, Institute of Human Biology, for the discussions which aided in the preparation of this paper, and to Drs. James A. Oliver and Arnold B. Grobman, Department of Biology, University of Florida, for their critical comments.

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The Rediscovery of the Toad *Bufo simus* Schmidt

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THE TOAD species *Bufo simus* was originally diagnosed by Oscar Schmidt (1857) in a paper entitled "Diagnosen neuer Froschen des Zoologischen Cabinets zu Krakau," as an "Auszug aus einer für die Denkenschriften bestimmten Abhandlung." The more complete description appeared in a second article (1858?), "Deliciae Herpetologicae Musei Zoologici Cracoviensis, Beschreibung der im K. K. Museum zu Krakau befindlichen, von J. v. Warszewicz in Neu-Granada und Bolivia Gesammelten. Ungeschwänzten Batrachier." The type series consisted of immature specimens with the cranial characters poorly developed. Because of this, perhaps, there has been confusion in the application of the name to adult toads. There are, however, in the descriptions of the species, two very distinctive characters clearly discernible in the young that are not or but little affected by later development. These are (1) the absence of openings (ostia pharyngea) from the pharynx into the Eustachian tubes, and (2) the concealment or absence of the tympanic membrane and the external earparts. These two characters will separate *B. simus* from all except two known species of Central American bufos: *Bufo bocourti* Brocchi and *Cranopsis fastidiosus* Cope. It would appear that the three species *Bufo bocourti, Bufo simus,* and *Bufo fastidiosus* form a group comprised by the unrecognized genus *Cranophryne* Cope.

Subsequent to the description of *Bufo simus,* the name came to be ap-

plied to certain Mexican toads, probably because of Günther (1901: 254-55), who was studying the Central American amphibians and believed that the name should also apply to the Mexican *Bufo intermedius* Cope (*nec.* Günther) which he placed in synonymy. He had available at this time one of the paratypes of *B. simus,* 17 mm. in length. It would appear that the association was made chiefly on the supposition that the tympanum was hidden under the skin rather than completely absent. A still more significant character was disregarded, this the absence of ostia pharyngea. Later authors discovered that *Bufo monksae* and *Bufo intermedius* Cope *(nec.* Günther), both of which have openings into the Eustachian tubes, were synonyms. Günther was followed in this error by Kellogg (1932: 63-67), and Smith and Taylor (1948: 42-43), who continued to apply the name *B. simus* to the Mexican species.

In 1949, while examining certain specimens in the Museum of Zoology, University of Michigan, I noted a toad from Boquete, Chiriquí Province, Panamá, that I suspected was the adult of the form described by Schmidt as *Bufo simus.* At least there was nothing inconsistent in this presumption save that the ostia pharyngea were absent [Günther, 1858: 139, states "eustachian tubes small"]. A re-examination of the type description showed that I, too, had overlooked probably the most significant character presented in the original descriptions—*the absence of ostia pharyngea.* This was due to my translation of the words *"aperturis tubarum eustachii absconditis"* as "openings of the Eustachian tubes hidden." However, the meaning intended obviously is 'closed' rather than 'hidden.'

Had this fact been taken into consideration, this species would never have been associated with *Bufo monksae* Cope, which has well-developed ostia pharyngea, or with *Bufo intermedius* Günther. That *B. intermedius* likewise has ostia pharyngea has been ascertained for me by Mr. H. W. Parker of the British Museum, who has had the kindness to examine the cotypes.

As stated above, the characters given in the description of *B. simus* apply likewise to two other species of toads, *Bufo bocourti* Brocchi and *Bufo fastidiosus* Cope. *Bufo bocourti* occupies a range in the northern part of Central America, occurring in Guatemala and Chiapas. The most important character in which *B. bocourti* differs from the adult of *B. simus* is that the parotoid glands in *bocourti* push forward and come in contact with the supraorbital crests so that they are separated from the eyelid by the narrow width of the crest only. *Bufo simus,* on the other hand, has a greatly thickened supratympanic crest or boss that separates the parotoid from the eyelid by a considerable distance. However, unless one observes carefully, the appearance is such that the gland and the boss together might be mistaken for an elongate parotoid gland reaching the eye. Certain other differences are evident in the presence of pre- and postorbital crests, parietal crests, larger lateral tubercles, and a lesser amount of webbing between the toes.

Bufo fastidiousus, known only from Pico Blanco, Costa Rica, differs from *B. simus* in the presence of a preorbital crest and in having the post-

orbital and supratympanic crests fused in a bony mass, not covered with skin. The mass extends down behind the eye to its lower level, covering the entire tympanic region. Scattered, large, lateral, wartlike tubercles of unequal sizes are present, and colored light on a dark background. Cope (1876: 97) stated: "The upper surfaces of the body and limbs are studded with round warts so closely on the latter regions as to resemble a pustular disease."

I present herewith a description of an adult male of *Bufo simus* (Univ. Michigan Mus. Zool. No. 58430, Boquete, Chiriquí Province, Panamá; Helen T. Gaige, collector).

DIAGNOSIS.—A large toad, the male reaching at least 72 mm. snout-to-vent length; canthal crests continuous with the supraorbital crests, which diverge and curve behind eye to the supratympanic crest; latter greatly thickened forming a boss; preorbital and postorbital crests absent; parotoid in contact, or continuous with the supratympanic boss; external auditory apparatus wanting and no trace of tympanum is evident under the skin ostia pharyngea absent; vocal sac absent, as are vocal slits in mouth.

DESCRIPTION.—Head deep, the width (26.5 mm.) greater than its length (23 mm.); greatest elevation of head 14 mm.; length of eye (7.3 mm.) slightly less than length of snout; latter extends slightly (2 mm.) beyond edge of lip; width of upper eyelid (5.5 mm.) much less than distance between orbits measured from the outer edge of the interorbital crest; supraorbital crests thickened, 2 mm. high; canthal crests less widened, terminating above nostril; in region between crests skin fused to bone of cranium; nostril oval, diagonally placed, its upper edge not reaching level of canthal ridge; a vertical calloused ridge on tip of snout widening toward notch in upper lip; a few small horny tubercles suggest a postorbital ridge; a few large warts back of tympanic area bear spinules; supratemporal ridge thickened, bulbous; parotoids small, scarcely larger than supratympanic crest; no trace of tympanum externally or below skin; no wide bony projection from supratympanic and postorbital ridges covering tympanic area.

Choanae small (0.47 mm.), the diameter of one contained in distance between them nearly five times; transverse palatal ridges broad, indistinct; tongue broader behind than in front, its width greater than its length, free for two thirds its length; no trace of a vocal sac, or vocal slits; no openings into Eustachian tubes.

Arm short; first finger shorter than second, bearing a large, hard, horny mass with nuptial asperities; a separate mass on outer side of the large metacarpal tubercle; a small discrete mass at dorsal base of second finger and scattered asperities on the inner edge of the distal part of same finger; little webbing, but this so thickened as to appear part of palm; outer (palmar) tubercle large, single; palm, in general, smooth; subarticular tubercles not or scarcely indicated on digits.

Leg moderately long, femur not greatly involved in body skin; no tarsal fold, or enlarged tubercles arranged in a row; inner metatarsal tubercle flat, moderately large, scarcely breaking outline of foot; toes approximately half webbed; subarticular tubercles not distinguishable; outer metatarsal tubercle

Bufo simus Schmidt. UMMZ No. 58430; Boquete, Chiriquí Province, Panamá.

irregular, outer part elongate oval; skin of sole wrinkled but neither tuberculate nor spinose; end of shortest toe reaches tip of snout; longest toe extends completely beyond tip of snout.

COLOR.—In preservative the color is yellowish olive, generally with an elongate lighter area bordering and including the dorsolateral row of tubercles. Sides darker, somewhat blackish in groin and on ventral and posterior surfaces of thigh, the dark color connecting on dorsal surface of thigh with the dark groin color; numerous yellowish or cream flecks on under side of thigh and a few on posterior surface; metatarsal and metacarpal tubercles cream-yellow.

MEASUREMENTS (in mm).—Snout to vent 72; snout to eye 8; width of head 27.5; length of head 21; head height at tympanum 14; length of eye 8; arm 40; longest finger 10; leg 81; tibia 25; foot and tarsus 43.

REMARKS.—The reduction or loss of the external auditory apparatus seems to bear a relationship to the loss of the opening into the Eustachian tubes and a concomitant loss of the vocal sac and slits. However, the latter apparatus may be lost even where the tympanum is present.

In the light of the facts here presented, the recent declaration (Firschein, 1950: 221) that *Bufo simus* is a *nomen dubium* would seem to be unfounded. That certain collectors failed to find the species in the general region of the recorded type locality is scarcely sufficient reason for questioning the validity of the recorded type locality. Not only is a locality given by Schmidt, but even the temperature of the water is recorded and certain other pertinent facts relating to the collection of the types are presented. Schmidt states: "Vaterland: Diese art war in ungeheuren Mengen an seichten Stellen des *Chiriqui* flusses, unweit *Bocca del Toro,* wo sie sich in einer Wassertemperatur von 36°–40° R. sehr wohl befanden."

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The Identity of the Ophidian Name *Coluber eques* Reuss [1]

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THE first attempt to allocate the name *Coluber eques* Reuss (1834: 152–155, pl. 8, fig. 2) was that of Boulenger (1893: 209), who attached it to a series of specimens (actually several closely related species and subspecies were included) from various localities over a considerable area in southwestern United States and México. In his admirable monograph of the genus *Thamnophis,* Ruthven (1908: 158–164) followed, with refinement, Boulenger's allocation. Smith later did the same (1942: 106–108), with, however, an expression of doubt based upon Reuss' illustration, which did not depict characters of the species to which the name had been allocated in the past. This doubt ultimately has proved well founded, thanks to the foresight and considerateness of Mr. K. P. Schmidt, who obtained a photograph (Pl. I) of Reuss' type of *Coluber eques* (Senckenberg Mus. No. 7209a) and took certain critical data, all of which he generously turned over to me.

The type of *Coluber eques* is a female with 155 ventrals, 25 + caudals, 23–21–19–17 scale rows, and a sharply defined lateral light stripe on scale rows 3 and 4. These data unquestionably demonstrate that the name has been misapplied in the past and actually belongs to the species currently known as *Thamnophis subcarinata* (Gray, 1839), which name *T. eques* antedates and replaces. The oldest name referable to the species previously known as *T. eques* is *Eutaenia cyrtopsis* Kennicott, 1860.

Three lines of evidence provide conclusive information regarding the subspecific identity of *Coluber eques*. The two subspecies of *T. subcarinata* currently recognized (*T. s. subcarinata* and *T. s. megalops*) differ as a whole solely in ventral and caudal counts. Since the type of *C. eques* has an incomplete tail, the ventral count is the only significant character remaining. In females of *T. s. subcarinata,* 39 percent (28) of 72 counts are 155 or less; in *T. s. megalops,* only 10 percent (4) of 40 counts are as low as 155. Accordingly, on this basis, the type of *C. eques* is more likely referable to the subspecies *T. s. subcarinata* than to *T. s. megalops*. The lower figures in ventral counts occur in about the same frequency in all parts of the range of *T. s. subcarinata,* however, and thus give no clue to the general area the type may represent.

Of greater significance, although not useful as a key character because of its limited geographic occurrence, is the pattern represented by the type found in this species only in the subspecies *T. s. subcarinata*. Ruthven (*loc. cit.*) and Brumwell (1939: 426–427) have described pattern groups in this species. The type of *C. eques* corresponds perfectly with Ruthven's third group (from Chalco, México), and with Brumwell's second group (from La Quemada, Jalisco). Both groups represent the southern subspecies (*T. s. subcarinata*). The pattern apparently does not occur in the northern subspecies. Again this character yields no dependable clue to the geographic provenance of the type of *C. eques*. Furthermore, on the basis of probability of access in the early 1800's, the southern subspecies is much more to be expected.

[1] Contribution from the Department of Zoology and Museum of Natural History, University of Illinois.

Type of *Coluber eques* Reuss, Senckenberg Museum, No. 7209a.

The synonymies of the species and subspecies, whose names are affected by the change in allocation of *Coluber eques,* follow. As has been indicated elsewhere (1950: 580) it is possible that the species *Thamnophis sumichrasti* and its five subspecies, as treated by Smith and Taylor (1945: 168), may eventually prove to be subspecies of *T. cyrtopsis* (formerly *T. eques*). Fortunately, if that eventuality arises, the change in names will be relatively slight, inasmuch as the more familiar *T. cyrtopsis* (1860) antedates *T. sumichrasti* (1866). It is a remarkable coincidence that one of the species whose name (*T. subcarinatus*) is changed herewith was, from 1938 until very recently (1949: 63–64), known by a still different name (*T. macrostemma*), and prior to 1938 by again another (*T. megalops*).

Inasmuch as the name *Thamnophis eques eques* (Reuss), not changed, is now known correctly to apply to a species different from that to which it has previously been attached, it is suggested that, at least until no confusion is likely, citation of the name in the sense here suggested be in the following form: *Thamnophis eques eques* (Reuss) Smith. All other recognized names remain with the forms to which they have been applied in the past.

Synonymy

Thamnophis eques eques (Reuss)

Coluber eques Reuss, Abh. Senck. Mus., 1834, pp. 152–155, pl. 8, fig. 2 (type locality "Mexico," restricted to El Limón Totalco, Veracruz, by Smith and Taylor, Univ. Kans. Sci. Bull., vol. 33, 1950, p. 351.[2]

Eutaenia subcarinata Gray, Zool. Beechey's Voyage, 1839, p. 96, pl. 32 col. (type locality Jaïisco, restricted to Guadalajara, Jalisco, by Smith, Herpetologica, vol. 5, 1949, p. 64).

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Eutaenia macrostemma Kennicott, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 331 (type locality México, D. F.).

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Eutaenia insigniarum Cope, Proc. Amer. Philos. Soc., vol. 22, 1884 (1885), p. 172 (type locality Chapultepec, D. F.).

Thamnophis megalops, Ruthven, Bull. U. S. Nat. Mus., no. 61, 1908, pp. 44–58 (part; includes *T. e. eques* and *T. e. megalops*).

Thamnophis eques megalops (Kennicott)

Eutaenia megalops Kennicott, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, pp. 330-331 (type locality either Tucson, Arizona, or Santa Magdalena, Sonora, restricted to Tucson, Arizona, by Smith and Taylor, Univ. Kans., Sci. Bull., vol. 33, 1950, p. 354).

Eutaenia macrostemma megalops, Cope, Bull. U. S. Nat. Mus., no. 1, 1875, p. 41.[3]

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[2] No specimens of this species have been recorded from El Limón Totalco, to which the type locality was restricted with the belief that the name applied to another species. Nevertheless the restriction is accepted inasmuch as occurrence of the species at that locality is a virtual certainty: elsewhere in Veracruz both of the species are recorded from Orizaba and Mirador. In addition, in Veracruz, *T. e. eques* is known from Acateno, *T. cyrtopsis cyclides* from Las Vigas.

The "Zool. Misc." frequently cited for the original description actually is an abbreviation of the title of Reuss' paper ("Zoologische Miscellen, Reptilien, Ophidier," pp. 130–162, pls. 7–9).

[3] This reference is listed by Smith and Taylor (Bull. U. S. Nat. Mus., no. 187, 1945, p. 163) by error under *Thamnophis macrostemma macrostemma.*

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Thamnophis cyrtopsis cyclides Cope

Thamnophis cyrtopsis cyclides Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 13, 1861, pp. 299–300 (type locality Cape San Lucas, in error; restricted to Guanajuato, Guanajuato, by Smith and Taylor, Univ. Kans. Sci. Bull., vol. 33, 1950, p. 330).
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Validation of the Use of Scales of Brook Trout, *Salvelinus fontinalis*, for Age Determination [1]

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THE brook trout or speckled trout, *Salvelinus fontinalis* (Mitchill), has long been a favorite of both the angler and fish-culturist in America. It may be stated safely for northeastern United States that more money and effort have been spent propagating, planting, and managing this sport fish during the last 75 years than for any other. In consequence, there exists for the species a voluminous literature, both technical and popular. Information is scant, however, on the growth rate of brook trout in wild populations. The state of such knowledge up to and for some years following 1900 is exemplified by Agassiz' oft-quoted nineteenth century reply to a query regarding the age of large brook trout from Rangeley Lake, Maine: ". . . no man living could tell, they might be 10 to 200 years old" (Kendall, 1914: 90).

Information on the growth rate of brook trout was still crude for the first three decades of the twentieth century: "It takes perhaps ten or fifteen years to produce a four or five pound trout under natural conditions. Who actually knows?" (Kendall and Dence, 1929: 272). About this time, however, the first results from using scales for age assessment in brook trout were published (Kendall and Dence, 1927), but these are of questionable reliability. Since 1932 only enough knowledge of age and growth in the species has accrued to show that scales might be used for age determination, to confirm the value of data on growth rate in management, and to establish the need for more information on these and related lines of study.

SCALES OF BROOK TROUT

General Description.—Brook trout have scales which completely cover the surface of the fish except for the head and fins; they are small and, consequently, often overlooked. Ordinarily, the fish is about 150 times as long as the greatest dimension of its largest scales (such scales on a 6-inch trout are about 0.04 inch long). The scales are cycloid, thin, roughly elliptical in outline, and slightly concavo-convex. More or less concentric ridges or circuli are arranged on the outer surface; the focus is relatively large and is centrally located; radii are absent (Pls, I-II).

Brook trout scales vary considerably in size and shape on different parts of the body. The largest ones are found where scales first appear, namely, on the caudal peduncle; the smallest ones occur on the throat. Scales also differ somewhat in size within any restricted area of the body.

Early Scale Development.—In Michigan, brook trout spawn in the fall of the year from October to December. The eggs are deposited in gravel and remain there for some time; the fry emerge from the bottom material after the yolk has been absorbed. During April, when the young are first seen in abundance, they are less than 25 mm. long. According to Elson (1939), it is

[1] Abstracted from a doctoral dissertation submitted in 1949 to the Horace H. Rackham School of Graduate Studies, University of Michigan.

at this length when the first gross evidence of scales may be seen in the form of small scale papillae. These scale papillae, and consequently scales themselves, do not develop at the same time over the entire body. They appear first in the lateral line, almost simultaneously from the head to the level of the adipose fin; subsequent development is most rapid on the caudal peduncle.

Tiny scale platelets develop within the previously formed papillae (Plate I, G). The first platelets to be seen, other than those in the lateral line, appear on the caudal peduncle both above and below the lateral line. They are thin discs with a slightly concave inner surface and a correspondingly convex outer one, similar to the bend of fully formed scales. The diameter of the initial platelets varies from 0.04 to 0.08 mm., and each forms only a part of the focus of the scale of which it is the rudiment. The focus is generally egg-shaped in outline (Plate I, H) and varies considerably in size. It usually approximates twice the dimensions of its orginal platelet. Measurements of foci or scales taken from the same fish as the original plates ranged from 0.09 by 0.13 mm. to 0.10 by 0.17 mm. through the widest and longest axes, respectively.

After the initial scale plates are formed, their growth proceeds very rapidly. The original platelets are soon surrounded by additional material and they subsequently attain various sizes by the time the first circulus is laid down. These initial plates may still be recognized within the focus after the scale is many months old. When two to three circuli have appeared, the scales are well imbricated both antero-posteriorly and dorso-ventrally; some overlapping may be noted even among enlarged scale fundaments before the appearance of circuli. At this time, scales in various earlier stages of development radiate in graded series from the site of first appearance. The anterior two-thirds of a forming scale (beyond the plate stage) lies in a dermal pocket and the posterior third pushes outwardly into the epidermis; the scale develops at a definite angle to the plane of the surface of the body. These observations are contrary to the views of Creaser (1926: 16): "Since all scales have their origin as separated imbedded plates, in the juvenile stage scales are circular in shape and may be termed regular cycloid scales. The scales of Salvelinus and some other fishes do not develop beyond the juvenile imbedded condition, remaining small and comparatively simple in structure and sculpture throughout life."

The first scales (other than those in the lateral line) form when the fish is about 40 mm. in total length. This initial scale formation usually takes place in May or June but depends largely on the size attained by the fry, as shown by collections made in different localities from April to Mid-September (Table I). The smallest fish with scales visible at 40 diameters of magnification was 35 mm. long; the largest fish without such scales was 42 mm. long. Scales were not evident in young brook trout taken in early April, but by July nearly all specimens collected had them. The delayed development of scales and the apparent relationship of initial appearance to the size of the fish, rather than to season, is shown in the persisting absence of scales from a few of the small fish collected as late as August and September (Table I).

When scales are removed from fish for age determination, they are customarily taken from a particular area. For obvious reasons, it must be determined whether scales fail to appear in this area before the time of first annulus

formation. In golden trout (*Salmo agua-bonita*), for example, some individuals did not form scales until the second summer of life (Curtis, 1935). In the Yellowstone cutthroat trout (*Salmo clarki lewisi*) as many as two-thirds of a population were believed to show no first winter-mark because of the absence of squamation during the first growing season (Robertson, 1947). Failure to form the first annulus in both of these examples was associated with extremely slow rates of growth. The possible occurrence of the same failure in brook trout is also associated with slow growth. I made extensive collections of small individuals in various localities in northern Michigan but, with a minor exception, all of the fish examined had scales on the sampling area (caudal peduncle) by the end of September. This observation was substantiated by additional

TABLE I

TOTAL LENGTHS (IN MILLIMETERS) OF BROOK TROUT AT TIME OF SCALE FORMATION

Locality (Michigan)	Date of collection	With scales		Without scales	
		Number of fish	Total length	Number of fish	Total length
N. Br. Au Sable R., Crawford County.	May 13, 1947	1	40	6	30–37
	May 12, 1948	14	41–53	62	24–42
	June 9, 1947	30	35–59	2	34–36
	July 10, 1947	27	43–79	..	.....
Hunt Creek, Montmorency County.	Apr. 9, 1947	..	.....	8	21–28
	May 10, 1947	..	.....	23	20–29
	June 7, 1947	2	43–46	12	33–41
	July 8, 1947	4	54–63	..	.....
Gangle L. and outlet, Montmorency County.	May 12, 1948	..	.....	9	20–23
	June 28, 1948	22	38–45	4	34–39
		59	46–55	..	.....
	July 20, 1948	12	42–55	1	36
	Aug. 18, 1948	7	35–39	5	32–38
		40	40–49	..	.....
		33	50–58	..	.....
	Sept. 11, 1948	15	37–45	2	34–35
		66	46–55	..	.....

collections of small fish in October, November, and January. The sole possible exception was in fish from Gangle Lake and its outlet stream system where the trout grow very slowly. Of 90 young-of-the-year collected on August 18, 5 had no scales; of 296 young taken on September 11, 2 still had no scales.

The Annulus.—The annulus or year-mark on scales of brook trout has been described by different authors as being identifiable by the pattern in which circuli are deposited on the outer surface of the scale. The crowding of adjacent circuli, irregularity or incompleteness in their formation, and the "cutting-over" of circuli in the postero-lateral areas, are the chief characteristics that have been employed. The criterion most useful to me was the sudden change in the growth pattern of the circuli. Since the annulus is not always of the same character on the scales of fish from different localities, practice and careful interpretation are required. Furthermore, experience and knowledge of the general biology of the species are sometimes needed in order to distinguish between true annuli and false ones.

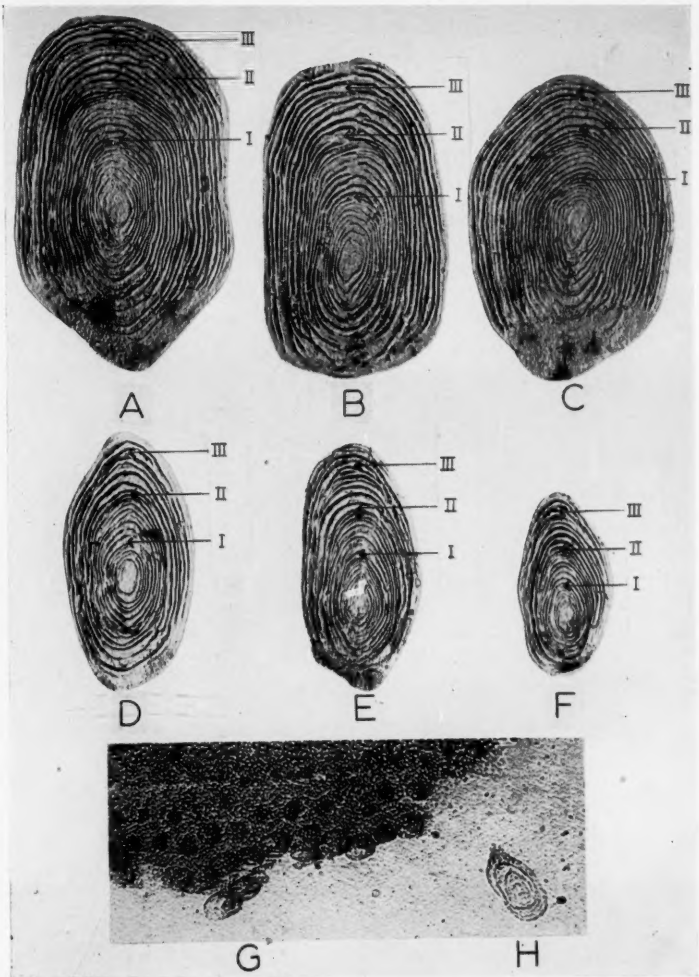
The annulus, as stated above, is a break in the growth pattern of the circuli. The exact limit is set as the outermost circulus deposited before the resumption of rapid growth in the spring. The scale must begin to grow anew before the annulus can be identified. Annulus formation occurs during April, May or June in Michigan depending on locality, water temperature, and perhaps on the age and rate of growth of the fish. In some European species of trouts (*Salmo*), the older and more slowly growing fish formed year-marks later than the younger and more rapidly growing individuals (Numann and Sella, 1943). Baldwin (MA thesis, 1948, Univ. of Toronto) suggested that increase in the scale, and probably in the body, length occurred earlier in the season among the younger than in the older brook trout in Redrock Lake, Ontario.

The annual growth pattern of the scales was disclosed by a study of a series of brook trout taken successively in each month of the year. The fastest scale growth takes place during May or June; circuli at this time are prominent and widely spaced. By the end of July, these ridges are being laid down more closely together. Through August this approximation of the circuli continues progressively, until by early September five or six circuli occupy as little space as did two of them in May. There is slight change in the appearance of the circuli from September until the following spring, when the pattern of fast growth is repeated.

As previously indicated, false annuli sometimes occur on brook trout scales. They may be due to a variety of causes. In a few of the streams studied, a mid-summer rise in water temperature nearly to the lethal limit for this species was accompanied by the formation of a false annulus. The appearance of the circuli and their spacing at this time resembled a true year mark. However, in these scales, the false annuli could be distinguished from the true ones because the time of formation of the false annuli could be traced by monthly collections made throughout the spring, summer and fall. Further study of such periodic series indicated that scales from fish of different ages from any one population usually exhibit these false annuli in the same relative positions, and true annuli are formed at the expected times and in their normal positions in spite of previous development of a false annulus.

Another example of false annuli was found in fish planted in O'Brien Lake, Alcona County. The original fish population was eradicated by the use of derris root on August 9, 1939, and on September 20, the U. S. Forest Service stocked brook trout in the lake. These presumably were young of the year, averaging about 4 inches in length. Scales from a sample of these fish taken about a month after planting showed a period of rapid marginal growth which probably occurred after the fish had been planted. There was an obscure growth check or false annulus about seven circuli from the margin. Samples taken the following July still exhibited this check, in addition to a true annulus formed during the spring of 1940.

Confusing accessory annuli or check marks are particularly common on the scales of brook trout reared to large sizes in hatcheries. Regardless of the causes of these marks, they make it difficult to age hatchery fish. These fish are also harder to age because of the absence of the pronounced seasonal changes in scale growth which are characteristic of most populations of wild trout. It was often possible to distinguish hatchery-reared brook trout from



A to F. Scales from different body areas of a mature male brook trout, total length 9.7 inches, collected from E. Br. Tahquamenon R., Chippewa Co., Michigan, on October 1, 1948, as follows: A, middle of side, posterior to dorsal fin; B, middle of side, anterior to dorsal fin; C, base of tail; D, throat; E, base of pelvic fin; F, nape. Annuli numbered I–III.

G and H. Scales from a male brook trout, total length 1.8 inches, collected June 9, 1947, from N. Br. Au Sable R., Crawford Co., Michigan. G, various growth stages (in situ) in skin, stained with alizarin; H, persisting scale platelet within focus on a scale with two circuli.

Scales from brook trout collected in Hunt Creek, Montmorency Co., Michigan. All fish were fin clipped in August, 1939, at 8 months of age. Total lengths in inches and dates of collection follow for figures A to J, inclusive. A, 2.8 inches, August 1939; B, 3.0 inches, February 1940; C, 3.3 inches, April 1940; D, 3.3 inches, July 1940; E, 4.8 inches, December 1940; F, 4.8 inches, March 1941; G, 5.7 inches, May 1941; H, 6.5 inches, October 1941; I, 7.0 inches, April 1942; and J, 9.6 inches, October 1942. Annuli numbered I-III.

naturally spawned ones by means of the pattern of circuli on the scales. Fortunately, all legal-sized hatchery trout had one or more fins excised before planting in 1947 and 1948 by the Department of Conservation and it was thus possible to eliminate these fish from the investigation.

Validity of the Annulus as a Year-Mark

In view of the wide application and general acceptance of the use of scales for age determination in fishes, it perhaps seems a bit academic to test the validity of the method for the brook trout. In addition, other members of the salmon family were among the first fishes to be aged by this means. The evidence accumulated for such species as the brown trout (*Salmo trutta*), the Atlantic salmon (*Salmo salar*), and the several species of Pacific salmon (*Oncorhynchus*) leaves little doubt as to the general validity of the method.

Nevertheless, several workers have doubted the accuracy of the scale method for age determinations of brook trout (Kendall and Dence, 1927; Ricker, 1932; King, 1942). Some of the circumstances contributing to the lack of confidence in this method follow: (1) the scales are minute and therefore difficult to study; (2) a rather high percentage of the scales are regenerated; (3) the relatively large foci of normal scales make it difficult to distinguish them from those with small areas of regeneration; and (4) in some instances, differences in scale growth between summer and winter are not distinct.

Notwithstanding the doubts expressed, many workers have aged brook trout by means of scales with the assumption that the method as used for other salmonids could be applied to this species (Hazzard, 1932, 1935; Greeley, 1934, 1935, 1936, 1937, 1939, 1940; Cooper, 1940; Rawson, 1941; Smith (PhD thesis, 1941, Univ. of Mich.); Shetter and Leonard, 1943; Cooper and Fuller, 1945; Doan, 1948; and Baldwin (*op. cit.*).

Establishment of the validity of annuli as year-marks by using fish of known age was accomplished as follows. In August 1939, one thousand wild brook trout were seined from an experimental section of Hunt Creek, Montmorency County, for a marking experiment. All of these fish were assumed at the time to be young-of-the-year and were sorted on the basis of size. A random sample of 50 individuals was weighed and measured and scales were taken from some of these. The scales had no annuli and this substantiated the previous assumption that the fish were in their first summer of life. For convenience, all of these fish were assumed to have hatched on January 1, 1939, although they may have hatched shortly before or after this date. The fish were marked by removing the left pectoral fin and were then returned to the same portion of the creek. At periodic intervals subsequent to this release, samples of these fish were obtained by intensive seining and by angling. At the time of recapture, the total length was again recorded, a scale sample was taken, and the fish were returned to the water. Such data were obtained from 173 fish during 38 months after the original release. Eighteen scale samples were discarded because they contained only regenerated or otherwise abnormal scales, but on all of the other fish the number of annuli on the scales agreed with the known calendar age of the fish (Plate II).

A duplicate of the previous experiment was started in August 1940, and almost identical results were obtained: 200 recoveries made over a period of

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35 months after release showed no differences between the known age and the age as determined by the scales.

Data from these two experiments were collected by various personnel of the Institute for Fisheries Research, as well as by the writer, and have been made available to me by David S. Shetter, In Charge of the Hunt Creek Fisheries Experiment Station.

Evidence to substantiate the method for fish more than 3 years old was obtained by tagging wild fish of various ages and recapturing them at a later date. Scale samples taken both at the time of tagging and at recovery made possible the comparison of the known age with the age determined from the annulus count. There was complete agreement between actual and scale-derived ages in more than 200 recoveries of such fish. Some of these fish were tagged during their third year of life (Age II) and recaptured during their sixth year of life (Age V). No recoveries were made of fish older than their sixth summer (Age V).

If the scale method for aging brook trout is valid, it is not only necessary that an annulus be formed once each year, but also that all scales from a single fish be consistent in depicting age. I have found this to be true. Despite the great difference in size, shape, and number of circuli of scales from different parts of the body, the growth pattern is remarkably similar in different scales from the same fish (Plate I, A to F). This is contrary to the observations of Ricker (1932: 77), who stated: "It is necessary to assume that the greatest age read is the correct one, since scales can usually be found which give a variety of lower readings."

It is only fair to emphasize that scales from all populations of brook trout are not uniformly easy to read. The lack of distinctness between summer growth and winter growth on some scales makes interpretation difficult unless adequate collections taken at different times of the year are available for study. The known-age fish from Hunt Creek are somewhat in this category. However, in other populations the marked difference in growth rate of the scale between summer and winter renders age determination relatively simple. In the doubtful populations, the tests for establishing the validity of annuli as given by Hile (1941) could be applied to gain use of the material.

Summary

The size and shape of brook trout scales vary considerably on different parts of the body.

The first scales form when the trout are about 40 mm. long. The size of the fish, rather than its age, is important in determining the time of first appearance of the scales.

In Michigan, all brook trout studied had scales by the end of the first year of life.

Annuli on scales of brook trout result from the sudden change of growth rate which is apparent by an increase in the distance separating successive circuli.

Annulus formation takes place during April, May and June, the exact time depending on locality, water temperature, age of the fish, and rate of growth.

Annuli in brook trout scales, as defined, are true year marks.

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Preliminary Observations on the Effects of Temperature and Light upon Reproduction in *Gambusia affinis*

AMMON B. MEDLEN [1]

A NUMBER of workers have demonstrated that light plays a dominant role, and temperature a subordinate one in controlling the seasonal cycle in the gonads of certain animals. Excellent reviews of the subject have been made by Bissonnette (1936) and Rowan (1938). However, most of the work has been done on homoiothermic animals, and the data on poikilothermic animals are incomplete and seemingly nonconclusive.

There is a limited number of reports regarding the experimental work on the effects of temperature and light in the seasonal cycles of fishes. In his investigation of the three-spined stickleback (*Gasterosteus aculeatus*), Craig-Bennett (1931) concluded that temperature was the important factor in controlling the sexual cycle and that light was unimportant. His conclusions were questioned by Rowan (1938) because the maximum amount of light used per day was of short duration. Tinbergen (cited from Rowan, 1938) reported that the stickleback was induced to breed at low temperature during the winter by means of light. Hoover (1937; Hoover and Hubbard, 1937) induced Brook Trout (*Salvelinus fontinalis*) and Rainbow Trout (*Salmo gairdneri irideus*) to spawn about four months in advance of normal spawning time by means of extended illumination. He suggested a classification of animals, as Garner and Allard (1920) did for plants, according to their sexual photoperiodicity, namely: those reproducing (1) as the day became shorter, (2) as the day became longer, and (3) without demonstrated relation to the length of day. Hoover (cited from Burger, 1939) also reported that light was ineffective in

[1] The author is indebted to Drs. S. O. Brown and G. E. Potter for their valuable advice and assistance.

yellow perch (*Perca flavescens*) which were kept in water below 44° F. Spaul (cited from Rowan, 1938) reported that the minnow, *Phoxinus laevis*, responded to light stimulation during autumn and winter months. Bullough (1939; 1940) investigating this species found that a temperature of 17° C. alone stimulated the early developmental stages of the gonads, and that the use of seventeen hours of light of day in conjunction with 17° C. temperature would stimulate the later developmental phases and induce the maturation of the gonads. He also found that the development of the ovaries in the females kept in total darkness was greatly retarded, while spermatogenesis, although slightly retarded, was able to proceed in the absence of light. He explained this as a cycle of gametogenesis capable of modification by seasonal environmental conditions. Through experimentation with a constant light period, Matthews (1939) concluded that while light initiated spermatogenesis it did not complete activation of the testis and that low temperature retarded sperm maturation in *Fundulus heteroclitus*. In his experiments with varying temperature and light on *F. heteroclitus*, Burger (1939) concluded that the spermatogenetic stages of the annual sexual cycle were not affected by light *per se* and that the temperature of the water was the important external factor regulating spermatogenesis. Dildine (1936) concluded that 23° C. was the optimum temperature for brood production in females of *Lebistes reticulatus* and that 18° C. and 28° C. were close to the survival limits of this fish. He found no significant difference between animals kept in the dark and those illuminated with ordinary electric bulbs. Histological examination of various maturation stages in the testes of specimens maintained at 18° C. and 23° C. showed no constant differences, but more animals were being checked against the apparent predominance of late maturation stages in the two individuals maintained at 28° C.

The various species of *Gambusia* are tropical and subtropical, viviparous fishes of the family Poeciliidae. They are widely known because of their use in mosquito control. The Malaria Control Units in the last war distributed them throughout the world where troops were stationed, for use as a natural mosquito control. This fish can be used extensively experimentally because it is prolific and easily reared. The organography of *Gambusia affinis* has been reported by Potter and Medlen (1935), and the structure of the testis, including spermatogenesis, by Medlen (1950). The light experiment here reported was designed to test some of the relationships of light and temperature to the reproductive cycle of *Gambusia affinis*.

Materials and Methods

Nine females and two mature males, as determined by the number of segments in the third ray of the gonopodium (Turner, 1947), were placed in each of three ten-gallon aquaria. In each aquarium the nine females comprised three large individuals (4½–5 cm. in length) born the preceding year, three middle-sized individuals (2½–3 cm. in length) born early in the year, and three immature individuals (about 1½ cm. long) born late in the year. The aquaria, equipped with aerating devices and supplied with sand and aquatic plants, were illuminated by automatically timed 150-watt, tungsten bulbs. All

aquaria were started with ten hours of illumination per day. The amount of light on the cold (48° F., 8.89° C.) aquarium and one of the warm (80° F., 26.67° C.) aquaria was increased one-half hour biweekly until seventeen hours of light per day had been reached. This light period was maintained until the end of the experiment. The third aquarium was limited to ten hours of light a day with a temperature of 80° F. (26.67° C.) for the duration of the experiment. Specimens receiving the normal day length light and temperature were used as controls. These individuals were obtained each time from the same natural environmental location in bar ditches near College Station, Texas. The duration of the experiment was from December 18, 1948, to May 7, 1949.

Results and Discussion

A small pigmented spot dorsal to the anus occurs in female poeciliid fishes before they are matured (personal correspondence from C. L. Turner). As they become mature and gravid, the spot becomes larger, reaching its maximum

Table I

Average Daily Temperatures (° F.) for the Area of College Station, Texas, 1948–1949

Data	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Average of daily maximum	86.0	72.3	68.9	58.9	66.0	71.8	75.1	88.5
Average of daily minimum	55.5	47.9	46.5	37.7	47.6	50.5	54.4	67.4
Average of daily averages	70.5	60.1	57.7	48.3	56.8	61.2	64.8	78.0

size shortly before the birth of the brood. This pigmented spot is referred to as the "gravid spot" (Gordon, 1943). After the brood is born, the gravid spot recedes, but there is never a complete loss of the pigmented mass. By careful observations on *Gambusia*, the experienced worker is able to detect the early increase in size of the spot, and thus obtain some idea of the early stages of pregnancy. Two large females in the warm and lighted aquaria were observed to have gravid spots on February 23, 1949. A sampling from the natural environment likewise showed large females to be gravid at this time. On March 12th, all large- and middle-sized females in the warm aquarium with increased light, and all large- and one middle-sized female in the warm aquarium with ten hours of light, were pregnant. On March 26th, all the females in both of the warm and lighted aquaria were gravid. Also, one large female in the cold and lighted aquarium appeared to be gravid, but within ten days she apparently reabsorbed the embryos, for the gravid spot disappeared and never reappeared during the progress of the experiment which terminated May 7, 1949.

Record of the water temperature in the natural environment is not available, but the daily air temperature was obtained from the weather station of the College. There was a continued decline of the temperature from October through January (Table I), and in February the average temperature began to rise progressively during the remainder of the experiment. The average temperature of the water in the environment during this time probably was

slightly below the average of that of the air. However, the critical temperature for gametogenesis and for fertilization cannot be calculated from the data with accuracy. From Table II it would appear that the critical temperature should be near 60° F. (15.56° C.), but additional investigation is necessary to determine it accurately. A temperature near 60° F. would be compatible with the report by Self (1940) that during the three years no wild specimen contained eggs during December, January, and February, although animals kept in the laboratory produced young during the winter months.

The writer has found that large females separated from males and maintained in the laboratory showed gravid spots at about the same time as the large females in the warm and lighted aquaria. This corroborates Dulzetto's statement (1928) that sperm which have been transferred to the female retain their power of fecundation for several months. Purser (1938) also found this to be true in the related fish *Lebistes reticulatus*. It is probable that the sperm in any female were derived from more than one male, because

TABLE II

POSTULATED CRITICAL TEMPERATURES FOR REPRODUCTION IN *Gambusia affinis* IN THE AREA OF COLLEGE STATION, TEXAS, 1948–1949

Number of days with temperature	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Above 55°F.	21	19	11	16	25	26	31
At 55°F. or below	9	12	20	12	6	4	0
Above 60°F.	14	10	7	11	19	21	31
At 60°F. or below	16	21	24	17	12	9	0

the mature female during the mating season is almost constantly followed by one or more males.

It has been shown in some vertebrates that light indirectly affects gonadal activity through the action of the hypophysis and consequent activation of the gonads. There is some evidence (Turner, 1948) that temperature acts by the same type of mechanism as light. However, there may be some stimulation of the gonad directly by temperature.

Since young females in the warm aquarium with extended light showed gravid spots sooner than females of the same age in other aquaria, it is possible that the combination of light and temperature is more effective than temperature alone. The temperature of the environment in this geographical region (Table I) is high enough to support reproduction during the fall months, but all data indicate that there is a lull in reproductive activity during this time. This might be explained on the basis that the females "spent" themselves in reproduction, and that they consequently need a short time for gonadal recuperation. This might account for the brood of embryos appearing in November (Self, 1940).

CONCLUSIONS

1. The temperature of the water is an important factor of the external environment regulating reproduction in *Gambusia;* light plays a minor role.

2. Sperm which have been transferred to the body of the female retain their power of fecundation for several months.

3. On the basis of the study of the air temperature it is suggested that the critical temperature for reproduction in the vicinity of College Station, Texas, is near 60° F.

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Additions to the Fish Fauna of Bermuda, with the Description of *Grammonus mowbrayi*, a New Brotulid

MARION GREY

THE brotulid and macrourid described here are part of a collection of fishes and invertebrates made over a long period of years at Bermuda by the late Mr. Louis L. Mowbray, and presented in 1948 to the Chicago Natural History Museum. The specimen of *Papyrichthys pellucidus* was given to this Museum by the Bermuda Biological Station, through the courtesy of the former director, Dr. Dugald E. S. Brown.

MACROURIDAE

Oxygadus occa (Goode and Bean)

Macrourus occa Goode and Bean, 1885: 595.
Oxygadus occa Parr, 1946: 89, figs. 24, 28.

Study material.—One specimen, Bermuda, January, 1908.

Description.—First dorsal 10, pectoral 17, ventral 7.

Measurements in millimeters, followed in parentheses by measurements in one-hundredths of total length: total length 425, greatest depth 62 (14.6), length of head 128 (30.2), tip of snout to vent 180.5 (42.5), barbel to vent 107.5 (25.3), tip of snout to dorsal fin 132 (31.1), tip of snout to pectoral fin about 125 (29.4), tip of snout to ventrals 138 (32.5), tip of snout to anal fin 182 (42.9).

Measurements in millimeters, followed in parentheses by measurements in one-hundredths of head length: width of head 53 (41.5), length of snout 55.5 (43.4), tip of snout to mouth 52 (40.5), horizontal diameter of eye 27.5 (21.5), vertical diameter of eye 17.5 (13.7), interorbital width 28 (21.8), length of barbel 10 (7.8), postorbital length 37.5 (29.3), base of first dorsal fin 17.5 (13.7), distance between dorsals 20 (15.6), length of pectoral 42 (32.8), length of ventral 30 (23.4).

Horizontal diameter of eye 49.5 of snout, its vertical diameter 63.7 of its horizontal diameter; barbel 18.0 of snout.

Origin of anal opposite that of second dorsal; ventrals inserted slightly in front of a vertical from the first dorsal ray; pectorals placed just behind head, in advance of both dorsal and ventral fins; underside of head scaleless but with scattered spinules; a few spinules in scaleless nasal pits; nasal pits broad above, narrowing below, reaching to suborbital ridge, which is at that point interrupted by a narrow fleshy area bearing small tubular pores.

Color.—In alcohol, uniform pale yellowish brown, inside of mouth dusky, peritoneum and linings of gill-cavities black.

Discussion.—*O. occa* has been known hitherto only from two specimens taken by the ALBATROSS in the Gulf of Mexico at a depth of 325 fathoms. A very closely related form, *O. labiatus* (Koehler), of which *O. talismani* (Collett) is a synonym, inhabits the Eastern Atlantic from the Faroe-Shetland

Channel to the Cape Verde Islands. This species differs from *O. occa* chiefly in the somewhat larger eye; the two will probably prove eventually to be forms of the same species. It is noteworthy, however, that Parr (1946: 91) described the inside of the mouth of *occa* to be of light color, whereas Farran (1924: 110) stated that *labiatus* has a deep blackish-blue mouth, the darker color evidently correlated with the deeper habitat of this species. The mouth of the Bermuda specimen of *O. occa* is dusky; the depth of its capture is not known.

BROTULIDAE

Grammonus mowbrayi, sp. nov.

Fig. 1.

Study material.—Holotype, CNHM No. 49185, total length 100 mm., standard length 89 mm.; and four paratypes, CNHM No. 50000, total lengths 103, 83, 79 mm., and one smaller specimen lacking the posterior portion of the body.

Description.—Dorsal 84 (type; 87 in largest paratype), anal 67 (type and largest paratype; another paratype with 64), caudal 9 (5 + 4), pectoral 23, ventral 1, vertebrae 40. Measurements and proportions are given in Table I.

Body stout, compressed, gradually tapering posteriorly to pointed tail, its greatest depth at origin of dorsal; head strongly arched from above eye to nape; snout low, rather broad; interorbital region flat; preopercular margin ending in two blunt spines; mouth large, the maxillary reaching well beyond posterior margin of eye, its posterior portion broadly expanded and bearing on the lower edge a blunt, retrorse spine (spine somewhat longer and directed forward in one paratype); narrow bands of villiform teeth in both jaws and on vomer, none on palatines; no large teeth present; tongue free, a cartilaginous knobby projection at tip; a single opercular spine; no pseudobranchiae; 3 gill rakers on first arch; scales small, cycloid, irregular, present on cheeks, opercle and occiput (rest of head naked), about 90 in a longitudinal series; lateral line double, upper one extending from gill opening to near end of tail, lower one commencing immediately below the upper and reaching a vertical from above vent, where it descends abruptly and continues posteriorly above anal fin to near end of tail; lateral lines not very distinct, the scales largely gone and the lines marked by small tubular flaps that are pigmented in the type and largest paratype but colorless in smaller examples (hence not easily seen); similar flaps scattered over head; vent just in front of anal fin, very slightly nearer tip of snout than base of caudal, about in middle of body; dorsal and anal continuous with caudal, bases sheathed with thin skin, rays fragile and difficult to count; bases of ventrals close together, the filamentous tips fragile.

Color.—In alcohol, brownish violet; scaleless parts of head, membrane outlining gill-opening, and pectoral fins brown; ventrals dark brown; vertical fins brown, generally darker at bases; peritoneum, inside of mouth, and gill opening pale.

Discussion.—*Grammonus mowbrayi* is apparently most closely related to *G. robustus* Smith and Radcliffe, a species known from the Philippine Islands and the Gulf of Aden. The Atlantic species differs in having two lateral lines, a more anterior vent, a spinous projection on the lower posterior edge of the

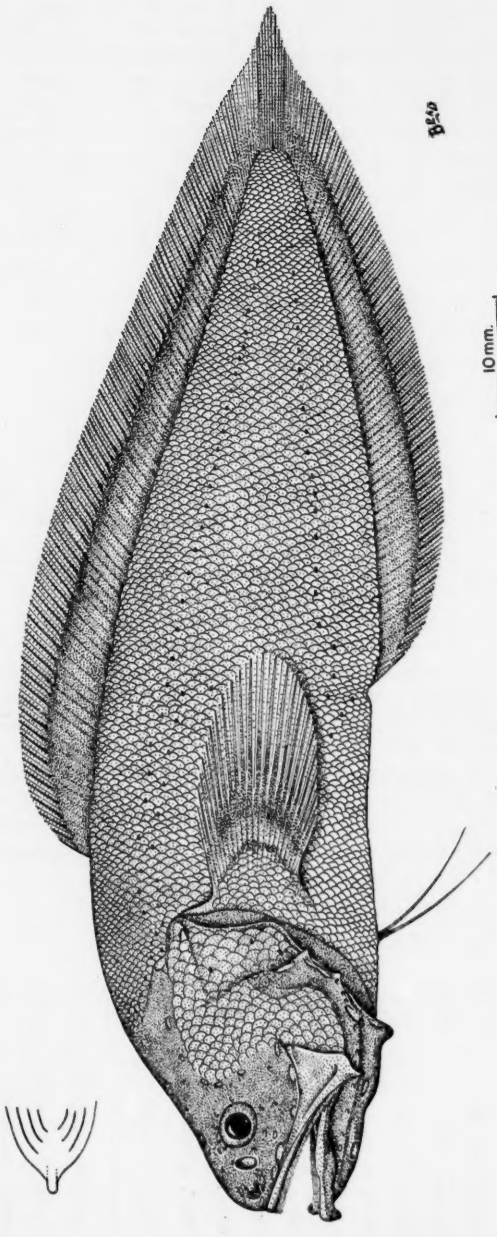

Fig. 1. *Grammonus mowbrayi*, n. sp., from the type, 89 mm. in standard length. Tongue and arches are outlined in upper, left.

TABLE I

MEASUREMENTS AND PERCENTAGES OF *Grammonus mowbrayi*

Character	Measurements in mm.					Percent of Standard Length				Percent of Length of Head				
	Type	Paratypes				Type	Paratypes			Type	Paratypes			
Total length	100	103	83	79	*	100	103	83	79	100	103	83	79	*
Standard length	89	91	73.5	68.5	..	100	100	100	100	..	..	..	..	..
Greatest depth	23	26	19	20	12	25.9	28.6	25.9	29.2	..	..	..	..	..
Length of head	26.5	27.5	23	20.5	14.5	29.8	30.2	31.3	30.0	..	..	..	..	..
Snout to dorsal	33	34	28	26	17	37.1	37.4	38.1	38.0	..	..	..	..	..
Snout to anal	44	45	36.5	33	25.5	49.5	49.5	49.6	48.2	..	..	..	..	..
Snout to vent	42	45	35	31.5	23.5	47.2	49.5	47.6	46.0	..	..	..	..	..
Dorsal base	60	61	49	47.5	..	67.5	67.0	66.7	69.4	..	..	..	..	..
Anal base	45	46	37	34.5	..	50.5	50.5	50.4	50.4	..	..	..	..	..
Width of head	15	16	11.5	11	7	16.9	17.6	15.7	16.1	56.6	58.2	50.0	53.6	48.3
Length of snout	7	7	5.5	5	3	7.86	7.7	7.5	7.3	26.4	25.4	23.9	24.4	20.7
Diameter of eye	4	4	3	3.5	2.5	4.5	4.4	4.1	5.1	15.1	14.5	13.0	17.1	17.2
Postorbital length	16.5	17.5	14	13	9	18.5	19.2	19.1	19.0	62.4	63.6	61.0	63.5	62.0
Length of upper jaw	15	15	12.5	11.5	8	16.9	16.5	17.0	16.8	56.6	54.6	54.5	56.0	55.1
Interorbital width	7	7.5	5.5	5	3	7.86	8.25	7.5	7.3	26.4	27.3	23.9	24.4	20.7
Length of ventral	12	14.5	9	11.5	8.5	13.5	15.9	12.2	16.8	47.0	52.7	39.1	56.1	58.6
Length of pectoral	18	18.5	15.5	13.5	9.5	20.2	20.4	21.1	19.7	68.0	67.4	67.5	66.0	65.5

* Damaged specimen, posterior portion of body missing.

maxillary, a slightly smaller eye, a longer snout, no pseudobranchiae or cilia, and slight differences in fin ray counts. Otherwise the two species are much alike and, although the differences mentioned might conceivably be due in part to individual variation or to sexual dimorphism, our scanty knowledge of the biology of the family Brotulidae necessitates a new name for the specimens at hand. Table II gives certain proportionate measurements of the two larger Bermuda specimens for comparison with similar measurements given by Smith and Radcliffe (in Radcliffe, 1913: 168) for *G. robustus*.

TABLE II

PROPORTIONATE MEASUREMENTS OF TWO SPECIES OF *Grammonus*
(Measurements in mm. are total lengths)

Character	*G. mowbrayi*		*G. robustus*
	103 mm.	100 mm. (Type)	143 mm. (Type)
Head length	3.75	3.78	3.87
Depth of body	3.96	4.35	4.21
Eye in head	6.88	6.64	5.7
Eye in snout	1.75	1.75	1.38
Snout in head	3.93	3.78	4.12
Maxillary in head	1.83	1.76	1.68
Snout to dorsal	3.03	3.03	3.15
Snout to anal	2.29	2.28	1.98
Ventral in head	1.9	2.3	2.47
Pectoral in head	1.48	1.47	1.40

G. mowbrayi is also rather closely related to *G. ater* (Risso), a Mediterranean species, from which it differs in having more dorsal and anal rays, an oblong (instead of round) eye, and a stouter body. From *G. armatum* (Döderlein), also a Mediterranean form, it is distinguished by fewer dorsal and anal rays, fewer vertebrae, the smaller and oblong eye, and only one opercular spine; and from *G. opisthodon* Smith, from South Africa, *G. mowbrayi* differs in its villiform teeth, more numerous dorsal and anal rays, and in having only one opercular spine. Smith has erected a new genus, *Grammonoides*, for *opisthodon*.

NOMEIDAE

Papyrichthys pellucidus (Lütken)

Fig. 2

Psenes pellucidus Lütken, 1880: 516, Fig. 601; Goode and Bean, 1895: 221, Fig. 228; Regan, 1902: 125; Bean, 1906: 49; Norman, 1930, 350, Fig. 40; Kamohara, 1938: 25; Miller, 1946: 208.

Psenes edwardsi Eigenmann, 1902: 35, Fig.; Miller, 1946: 209.

Papyrichthys pellucidus Smith, 1934: 94, Pl. 6, Fig. A; 1949*a*: 305, Fig. 851; 1949*b*: 846.

Caristioides amplipinnis Whitley, 1948: 88, Fig. 8.

Study material.—One specimen, CNHM No. 49189, a non-breeding male, taken from a fish pot off the south shore of Bermuda; depth and date of capture unknown.

* Damaged specimen, posterior portion of body missing.

Description.—Dorsal XII–I, 30; anal 31; pectoral 19; ventral I, 5; above and below pupil.

Measurements in millimeters, followed in parentheses by measurements expressed in one-hundredths of the standard length: total length 173, standard length 135, length of head 43 (31.8), depth at origin of anal fin 50 (37.0), width at shoulder just behind head 14 (10.3), tip of snout to origin of dorsal fin 47.5 (35.2), tip of snout to pectoral 42 (31.1), tip of snout to ventrals 47.5 (35.2), tip of snout to anal 74 (54.8), length from vent to base of middle caudal rays 69 (51.0), length of pectoral 28 (20.7), length of ventral 28 (20.7), least depth of caudal peduncle 8 (5.92), length of caudal peduncle 17.5 (12.9), length of snout 12 (8.9), diameter of bony orbit 14 (10.3), interorbital width 14 (10.3), postorbital length 20 (14.8), longest dorsal spine (perhaps broken) 10.5 (7.79), longest dorsal ray 22.5 (16.7), longest anal ray 23.5 (17.4).

Measurements in one-hundredths of length of head: snout 28, orbit 32.6, postorbital 46.5, interorbital 32.6.

Body compressed, flabby; regions below the two dorsal fins and above the anal fin very thin, translucent; head bones thin, flexible; top of head soft, spongy; edge of interopercle with minute spines, scarcely discernible to the naked eye; eye surrounded by a narrow adipose membrane, somewhat widened antero-ventrally; nostrils close together, situated at tip of snout; mouth reaching a vertical from anterior portion of pupil, the maxillary almost entirely hidden by membrane; teeth as described by Smith for the South African specimen, small, pointed, in single rows in jaws, none on palatines, perhaps present on vomer; gill rakers 15 + 6; pseudobranchiae well developed; scales very small and thin, covering body and extending onto bases of dorsal, anal and pectoral fins; those on head covering cheeks and running across upper parts of preopercles and opercles, with a few scales along lower edge of opercles, remainder of head naked; lateral line high, following dorsal profile, ending on caudal peduncle below last dorsal ray; dorsal origin just behind nape, the spines fragile but well developed, partially broken, middle spines apparently longest; soft dorsal high, seventh to fifth rays from posterior end longest, last four rays shorter; anal origin behind that of soft dorsal, fifth to thirteenth rays from posterior end longest, last four rays shorter, the fin similar to soft dorsal in shape; caudal fin long, shallowly forked; pectorals rounded, inserted slightly behind a vertical from first dorsal spine, the bases oblique; ventrals inserted below posterior portion of pectorals, their bases very close together, their tips just reaching origin of anal fin, fitting into groove in abdomen, inner rays longest.

Color.—In alcohol, uniform pale brownish, translucent just below dorsal and above anal fins; pectorals colorless; ventrals with an irregular dusky streak at base of rays, the tips dark brown; caudal edged with dark brown; first dorsal dark brown; soft dorsal and anal light, with dark edges and a dark stripe at the base of the rays; upper parts of head and body with very fine brown puncticulations which also are present inside the mouth and on a patch inside the operculum; peritoneum dark brown; iris black, with a golden stripe vertebrae 41.

Discussion.—The genus *Papyrichthys*, described by J. L. B. Smith (1934: 93), was based on a South African fish identified by him with Lütken's *Psenes pellucidus*, which was designated as genotype and of which Dr. Smith had no

other specimens. He assumed that the difference in depth between his specimen and the one figured in Goode and Bean was due to inaccurate observation by these authors. However, examination of several specimens of *pellucidus* proves that they are proportionately deeper; and a comparison of these with the two larger examples from South Africa and Bermuda indicate that the latter represent either a new species or older (adult) stages of *pellucidus*.

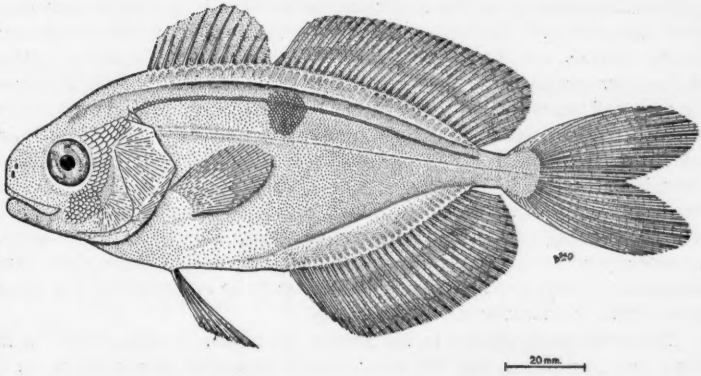

Fig. 2. *Papyrichthys pellucidus* (Lütken), from a specimen (CNHM No. 49189) 135 mm. in standard length.

Specimens examined include the one described above, the South African example, a specimen 54 mm. in standard length recorded by Bean (1906) from Bermuda, and twenty-three specimens loaned by the U. S. National Museum. The latter, from 10 to 61 mm. in standard length, include the fourteen examined by Miller (1946), from six Albatross stations off the Atlantic coast of the United States from Cape May, New Jersey, to the Gulf of Mexico, and the following: USNM No. 84508: 8 specimens, ALBATROSS Hydrographic Station 962, lat. 23° 13′ 00″ N., long. 81° 34′ 30″ W., April 4, 1886, off Matanzas, Cuba. USNM No. 134019, 1 specimen, GRAMPUS (Bache) Station 10209, lat. 27° 57′ N., long. 78° 15′ W., 1914, off the east coast of Florida.

X-ray photographs of the specimen recorded by Bean, and of four of the small American specimens, show 41 vertebrae (including hypural).

As pointed out by Miller (1946: 209) it is possible that the American *P. pellucidus* may differ from Indo-Pacific specimens. It is therefore of interest to note that the large Bermuda specimen differs from the South African example in having fewer rays in the soft dorsal and anal fins, a wider interorbital space, and relatively shorter ventral fins (a growth character). Smith has informed me that although the published descriptions indicate 13 gill rakers, his fish actually has 15 on the lower limb of the first gill arch. As Miller also stated, the name *P. edwardsi* Eigenmann is available for the western Atlantic form if the two should prove to be distinct.

Although the assumption that the larger specimens belong to the same species as the smaller ones is somewhat arbitrary, it is considered practical at present to include all described specimens under one name, as otherwise the South African example and the one described above would require new names. However, some species of the family Nomeidae are known to undergo great changes during growth: the young are much deeper-bodied and their ventral fins are relatively much longer. Thus the greatest differences between *pellucidus* and the two larger specimens under consideration here can be explained largely by the difference in size. The larger specimens differ from smaller ones in the more elongate body, the longer and higher snout, the somewhat smaller eye, shorter ventrals, and the less steep profiles of the head and the ventral outline. In the older specimens the slope from tip of snout to nape is even and convex, the eyes well below the upper profile, while in small specimens the interorbital region is flattened and the profile rises steeply to the nape, the eyes entering into the upper profile. However, the snout and interorbital regions in the larger examples are raised by added fatty tissue, which the smaller ones lack, and this additional flesh is probably acquired with age, changing the angle of the profile accordingly. Small specimens are very deep anteriorly, with a steeply ascending profile from vent to caudal, while in the more slender, older fishes this profile is lower and more gradual, a change to be expected with the diminishing depth so characteristic of the family.

The peritoneum, silvery in the smaller specimens, is dark brown in the larger ones, indicating that the latter inhabit somewhat deeper water. In all other characters, such as teeth, scales, texture of body, color, height and position of vertical fins, etc., the fishes are in close agreement.

The following measurements in millimeters have been made on the South African specimen, which is in very bad condition and difficult to measure. The numbers in parentheses represent one-hundredths of the standard length. Comparison demonstrates that the proportions are close to those of the Bermuda specimen, except in length of ventral fins and width of interorbital—differences believed to be due in part to the poor condition of the South African fish. There is also a slight difference in the length from vent to base of middle caudal rays.

Total length 110.5, standard length 98, length of head 30.5 (31.2), depth at origin of anal fin 37 (37.8), width at shoulder just behind head about 10 (10.2), tip of snout to origin of dorsal fin about 32 (32.7), tip of snout to pectoral 31.5 (32.2), tip of snout to ventrals about 36 (36.7), tip of snout to anal 55 (56.1), length from vent to base of middle caudal rays 54 (55.0), length of pectoral about 22.5 (23.0), length of ventral about 25 (25.5), least depth of caudal peduncle 6 (6.13), length of caudal peduncle from end of anal to base of middle caudal rays 12.5 (12.7), length of snout about 8.5 (8.67), diameter of bony orbit about 9.5 (9.7), interorbital width 6 (6.13), postorbital length about 15 (15.3).

Measurements in one-hundredths of length of head: snout about 27.8, orbit 31.2, postorbital about 49.1, interorbital 19.7.

The author wishes to express her gratitude to Mr. Loren P. Woods for his generous advice during the preparation of this paper, and to Miss Margaret Bradbury for her careful execution of the figures. I am also grateful to Dr. J.

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Nocturnal and Feeding Behavior of the Labrid Fish *Xyrichthys psittacus*

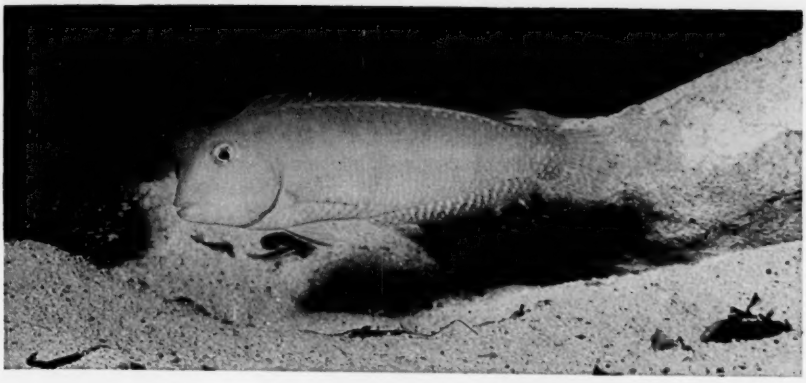
C. M. Breder, Jr.

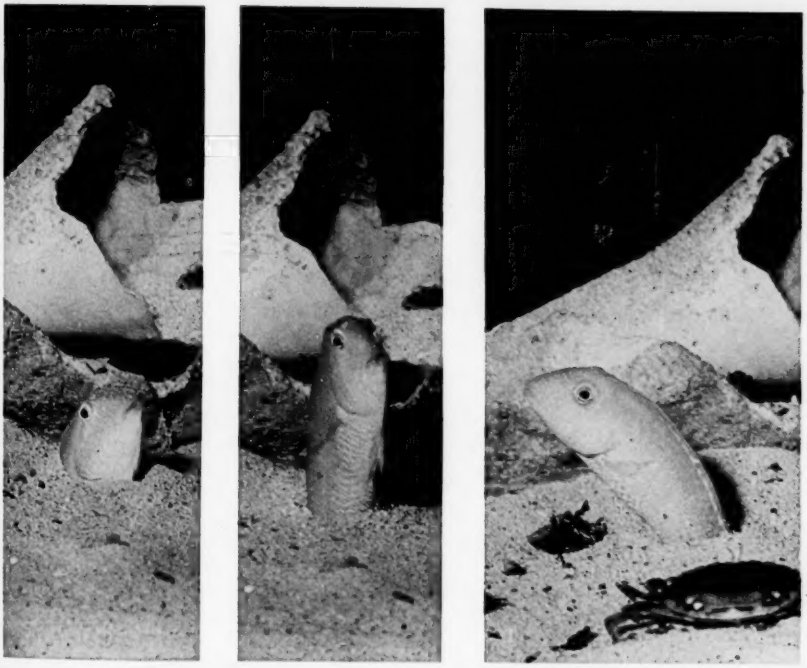
IT IS well known that a variety of labrid fishes spend the night buried in sand. This is known from first-hand observations on the genera *Halichoeres*, *Thalassoma* and *Xyrichthys*. They exist under a clear handicap and poorly in containers which do not have a depth of sand at the bottom under which they may spend the night. The behavior of the razorfish, *Xyrichthys psittacus* (Linnaeus), in the sea has been described by Longley, (*in* Longley and Hildebrand, 1941: 200) as follows:

> "Not only is the species confined to a certain sort of bottom, but most of its members appear to have particular spots to which they return after their rather limited excursions afield. This observation is confirmed by the fact that the same fish may repeatedly lead one to the same place. On the *Xyrichthys* ground north of Loggerhead Key as many as twenty selected spots, marked and protected, may be seen at once by a diver. On each, when the work is complete, stands a conical mound of coral fragments, which may measure as much as 14 or 15 inches in diameter at the base, rise to a height of 6 inches, and enclose a crater 3 or 4 inches in diameter, whose bottom is loose stirred sand.
>
> "*Xyrichthys* picks up and tosses its material into position, handling it in an orderly way, with determinate and serviceable results. If pieces from the rim of its building be toppled into the pit, they are removed and laid again in position. So it seems that such a shelter is heaped up with considerable expenditure of effort, is kept more or less in a state of repair, and is a semipermanent habitation, usually occupied, I think, by one fish only, which may often be seen resting beside or above it."

In the confines of a small aquarium, two feet by one by one, no such constructional behavior is displayed, but there is an item of behavior that *Xyrichthys* does display which it would be almost impossible to study in the field, but which is unquestionably tied up with its normal "house building" behavior. With the coming of dusk these fish force their way easily into the loose calcareous sand in a manner similar to the two other genera mentioned above. Those two bury themselves completely, leaving only their mouths at or near the surface of the sand and are generally so covered as to be fully hidden. *Xyrichthys*, on the other hand, while performing in a generally similar fashion, protrudes its head and sometimes more or less of its body (Plate I). In this position it will "sit" in the failing light and "ogle" its mobile eyes, optically following any small active object that may be moving about. This will go on until the light fails nearly fully, at which time the fish will rebury itself completely. It would seem almost certain that this behavior is associated with what the species does during dusk in the open in reference to its habitation and that these aquarium observations are an approximation of such behavior modified by the shallowness of the aquarium sand.

When lights were permitted in the laboratory during this time of day, the bedding-down activity was extended to some extent but not obliterated,





Behavior of *Xyrichthys* at dusk.
Upper: Individual as seen when selecting site for spending the night.
Lower: Three typical poses assumed before final retirement for the night.

there evidently being a ryhthm in the matter as well as a response to light intensity. Blinded *Halichoeres bivittatus* (Bloch) bury themselves immediately and remain buried for long periods, several days to a week, when evidently hunger forces them out in "darkness" to forage.

At one time a small *Sparisoma abildgaardi* (Bloch) was kept with the *Xyrichthys*. This parrotfish does not bury itself on the advent of night but merely retires to a corner or crevice and rests quietly. These two fish stayed in the company of one another most of the time. When evening fell and the razorfish performed as above described, the parrotfish would circle around and around the upstanding part of the former, protruding from the sand, in a manner suggesting that this non-parrotfish behavior was inducing some "disturbance" in the *Sparisoma*. The latter would eventually retire to a corner well after dark.

Although Longley found "crabs and fragments of mollusk shells" as the stomach contents of *X. psittacus*, the individual under discussion refused everything offered other than crustaceans. Small crabs gave the fish no trouble at all, but a larger portunid that could easily reach the rearward displaced eyes of this fish presented a problem. It made some tentative nips at the crab from the rear but inflicted no damage. Eventually the crab buried itself in the sand. Almost immediately the fish attacked one protruding "elbow" and succeeded in snapping off one claw. It swam off with this and broke it to pieces by striking it sharply against the shell seen in the photographs. It may be that the coral fragments which these fish accumulate in a wild state are useful for them to have at hand because of this detail of feeding behavior.

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On the Use of the Terms *Abundance, Availability* and *Apparent Abundance* in Fishery Biology [1]

John C. Marr

RECENT discussions with several fishery biologists have demonstrated that the terms *abundance, availability* and *apparent abundance* do not have the same meanings to different individuals. Since these terms, or at least the concepts for which they stand, are important ones, the following definitions and remarks are set down with the hope of dispelling rather than adding to the confusion.

The terms may be defined briefly as follows: *Abundance* is the absolute number of individuals in a population. *Availability* is the degree (a per-

[1] Published by permission of the Director, Fish and Wildlife Service, U. S. Department of the Interior.

centage) to which a population is accessible to the efforts of a fishery. *Apparent abundance* is the abundance as affected by availability, or the absolute number of fish accessible to a fishery. While abundance is of primary concern, it is most often apparent abundance which is measured. And since the measure (catch per unit-of-effort, for example) for a particular period is often only relative to similar measures for other periods, it should be termed *relative apparent abundance.*

The abundance of a particular year-class at a particular time is a function of the number of eggs spawned and the subsequent mortality suffered from all causes. That is, obviously,

$$N_{at} = N_{ao} - M_{at} \quad \ldots\ldots\ldots\ldots (1)$$

where N_{at} is the number of individuals in year-class a at time t, N_{ao} is the number of eggs spawned or initial abundance of the year-class at time zero, and M_{at} is the number of deaths from all causes between time zero and time t. For a population which includes more than one age group or year-class (say n age groups), we may sum over all age groups to get the abundance of the whole population.

$$N_t = \sum_{a=1 \text{ to } n} (N_{ao} - M_{at}) \quad \ldots\ldots (2)$$

One important feature of abundance is that it is the sum of all the previous experience, with respect to "births" and deaths, up to time t, of all year-classes in a population at that time. Part of this experience, and perhaps the most important part, may have occurred at a considerable number of months or years before time t. With reference to the determination of N_t, the definition (2) above does not attempt to assign relative importance to initial abundance, fishing mortality and natural mortality. This will no doubt vary between fisheries and even between periods within a single fishery. The assignment of relative importance to one or another of these by the biologist will perhaps be conditioned by the type of fishery with which he is most familiar (i.e., especially pelagic fishery *vs.* bottom fishery).

Works in which estimates of abundance have been based on tagging (or marking) experiments or, much more rarely, on estimates of the total number of eggs produced during a spawning cycle are familiar to all. Indirect estimates of abundance based on the characteristics of the commercial catch have also been developed (see Silliman, 1943, for example).

Availability, which is a percentage or fraction of abundance, may be designated by r. The mechanisms which determine the fraction of a population that is available to a fishery must be rather complex and undoubtedly vary widely between, as well as within species with respect to time and geographical location. These mechanisms may be divided into two kinds: intrinsic ones which are the response of the fish to its environment, and extrinsic ones which are completely independent of the behavior of the fish. Considering first the intrinsic mechanisms, several conditions of r are possible. It may be constant and be zero, or 1.0, or some intermediate value. If it were zero, no fish would be available and if it were 1.0, the entire population would be available. One can imagine a small stream from which it would be possible

to catch every ascending fish, with gear located in the stream. One can further imagine that this stream has a fall run of salmon which are fished only while in the stream. In the spring, or at any time before the run started, availability would be zero and no fish could be caught. During the course of the run the entire population could be caught and, considering the entire period of the run, the availability would be 1.0. If only a constant percentage of the population, say 5 percent, entered the stream each day, the daily availability would be constant and would be 0.05.

Probably a more common situation is one in which r is not constant, but varies in response to varying environmental conditions. An example may be present in the Oregon-Washington pilchard fishery, where a negative correlation between the catch per unit-of-effort for each of nine seasons and the average monthly air temperatures during the season has been demonstrated (Marr, 1950). A special case of this type of varying availability is found in fisheries in which the youngest age groups are not as available to the fishery as are the older age groups. Such young age groups are often spoken of as being not fully recruited into the fishery.

For some species, availability may be constant (and be zero, 1.0, or some intermediate value) at some times and variable at others. The sei whale fishery off the Norwegian Coast (Hjort and Ruud, 1929) is an example. No sei whales are taken in that region before the rapid spring increase in the total stock of the copepod *Calanus finmarchicus*. At this time r is constant and zero. At the time of rapid increase in numbers of copepods, the catch of sei whales parallels copepod abundance, with a slight time lag; the availability is then variable.

These and similar examples do not, of course, explain what is happening any more than the recapture of a marked salmon in its parent stream explains the homing instinct.

There are several kinds of extrinsic factors that can affect availability. Perhaps the most common is the weather. All fisheries suffer periods when unfavorable weather conditions seriously hinder or completely prevent fishing. The catch is lowered by the inability of the fishermen to go to sea and operate their gear, not by reduced abundance or any unfavorable behavior of the fish. Of course, as indicated above, weather may also have an influence on fish behavior.

In trawl fisheries bottom topography must be an important factor. It is easy to imagine two banks of equal area with equal numbers of flounder distributed evenly over each bank. One bank is relatively smooth and trawls can be operated with full efficiency over the entire bank. For the fish on this bank r would be 1.0. The other bank is relatively smooth over one-half of its area, while the other half is so rough and irregular that it is impossible to drag a trawl over it. For this bank r would be 0.5.

Finally, availability may be more complicated than any of the examples given would indicate. It may be determined by the simultaneous operation of a complex of factors, rather than by a single factor. Or it may be determined by one complex of factors over a certain range of their values and, outside that range, be controlled by a different complex of factors.

In general, availability is not well understood for most fisheries and, in

fact, a great proportion of the processes involved still remain to be recognized and analyzed. Variations in availability in time and space, and even with respect to different age groups within a population at a single place and time, or with respect to population size, are little known. However, for fisheries that are pursued over the entire range of the species involved, it might be expected that variations in availability would generally be less important than variations in abundance in determining the yield (ignoring, for the present, fluctuations in fishing intensity). For fisheries that are carried out over only a portion of the range of the species involved (as, for example, over part of a migratory route), it might be expected that variations in availability would often be more important than variations in abundance in determining the yield. (In actual practice, it will often be necessary to work with catch data and to deal with relative availability rather than with absolute availability. Under certain conditions it will ordinarily be impossible to distinguish between a change in availability and a change in rate of natural mortality. The collective effects of these two factors may be termed *accessibility*.)

In contrast to abundance, which, in general, is determined by events spread over a considerable period of time, availability may bear a much closer temporal relationship to the processes determining it. Indeed, the processes and the results may often be simultaneous, for all practical purposes.

It should be clear that the size of the available population upon which a fishery operates will be rN_t, the apparent abundance. All methods of estimating abundance, N_t, which are based in one way or another upon original catch data, will actually be estimating apparent abundance. As r approaches unity the estimate of apparent abundance will, of course, approach the true abundance.

The most common estimates of apparent abundance are relative and are measures of catch per unit-of-effort. However these may be derived, they are in effect equivalent to the total catch divided by the total effort, $\frac{C}{f}$, for the time interval selected. Workers developing measures of relative apparent abundance frequently assume, tacitly or explicitly, either that r is unimportant or that it is constant. There is the further assumption, more frequently tacit than explicit, that a measure of relative apparent abundance is some constant proportion of abundance. That is, that (including availability)

$$\frac{C}{f} = krN_t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where k is some constant.

If the relationship in (3) above obtains, and assuming for the moment that r is unity or some constant percentage, Ricker (1940) and others have pointed out that the definition of N_t will have to be qualified or modified according to the period of time over which the catch per unit-of-effort is calculated. For example, $\frac{C}{f}$ for a season of several months duration would be proportional to the average abundance over the entire season, rather than to the abundance at the beginning of the season. It will, of course, also be proportional to the abundance at some particular instant during the season,

but this particular instant generally will not be known. This is of parenthetical interest here, since it affects the application of the concepts, rather than the concepts themselves. (Such application should also include consideration of factors such as the intensity of the fishery, competition between effort units, etc., which are not included in this discussion).

Ricker (1940) has commented at some length on the relationship between catch per unit-of-effort and abundance (or, more properly, apparent abundance). A clear understanding of the relationship is essential and reference should be made to that work, since it is my intention only to define and to suggest terminology concerning concepts which need to be clarified. Clarification is needed because of the use of the same term for different concepts and because of confusion caused by tacit assumptions. A few examples, chosen more or less at random, will demonstrate the non-uniformity of application of these terms. Quite commonly the terms used are not defined and it is therefore up to the reader to decide from the context exactly what the writer meant. Thus, misunderstandings may readily arise.

Pearson (1948), referring to the blue-crab fishery of Chesapeake Bay, has regarded catch per unit-of-effort as an index of abundance; that is, that catch per unit-of-effort is proportional to abundance. This is the equivalent of relative apparent abundance as defined above and tacitly assumes that r is constant. He recognized availability and used that term without explicitly defining it. His use of it is sometimes in the sense that it is defined above and sometimes in the sense of relative apparent abundance.

This example represents perhaps the most common usage; catch per unit-of-effort regarded as proportional to abundance, either with or without recognition of availability. There is, however, considerable variation in terminology. Schuck (1949), in his study of the New England haddock fishery, used "relative size of the population" as an equivalent to my "relative apparent abundance." He used availability in the sense that it is used here, but did not define it. Some of the European workers, Strubberg (1939) for example, referred to catch per unit-of-effort as a measure of the density of the stock. Again, the implication is that catch per unit-of-effort is proportional to abundance. Fry (1949: 38), in a lake trout fishery study, used "The yield per effort . . . or availability . . ." This is evidently the equivalent of relative apparent abundance. His use of "catchability" may correspond to my use of "availability." Similarly, Needler (1948: 166), in a general discussion, stated that catch per unit-of-effort ". . . is practically synonymous with availability or the ease with which fish can be obtained."

Sette (1943: 5), in his discussion of a fisheries research program, gave this definition: "At uniform availability and with no competition between units of gear: Relative abundance = catch-per-unit-of-effort. . . ." This is essentially the same as the definitions offered here. Sette (1949) has used apparent abundance and availability as defined above and I have previously so used these terms (Marr, 1950).

These examples certainly indicate the non-uniformity of terminology, and also show that a clear understanding of the underlying concepts is not always held. It is obviously essential that empirical data be associated in the investigator's mind with the appropriate concept. It may, in fact, be desirable

to reserve the terminology suggested here for use in denoting these concepts only. In the following tabulation are listed the concepts and their empirical equivalents.

Concept	Empirical data from which values may be estimated
Abundance	Estimates based on tagging or marking experiments, assuming r to be constant and unity, or, when r is variable and less than unity if the value of r is known; estimates based on number of eggs produced during annual spawning cycle (applies only to abundance of spawning population); direct enumeration (such as weir counts).
Availability	Variations in catch not associated with abundance or fishing intensity, but rather with variations in environmental factors.
Apparent abundance	Estimates based on tagging experiments with r variable.
Relative apparent abundance	Catch per unit-of-effort data.

In summary, *abundance*, *availability* and *apparent abundance* denote three important and distinct concepts in fishery biology. Confusion has arisen owing to the non-recognition of one or more of these concepts, to the wide range of terms used to represent the same concept, or to the use of the same term for different concepts. While the terms used here seem reasonably apt, they are not those in widest use and perhaps more appropriate ones could be suggested. However, standardization would not be essential if workers would define their terms adequately.

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SOUTH PACIFIC FISHERY INVESTIGATIONS, U. S. FISH AND WILDLIFE SERVICE, 450-B JORDAN HALL, STANFORD UNIVERSITY, CALIFORNIA.

Ichthyological Notes

THE OCCURRENCE OF EGG CAPSULES IN THE WINTER SKATE (*RAJA DIAPHANES*) IN MAINE WATERS.—In 1949, Maine fishermen landed large quantities of spiny dogfish and skates, which were used for fish meal. The opportunity to examine some of the skates was provided me by the Maine Fish Meal Company of Portland, Maine. I inspected the entire catches of several line-trawl boats on September 6 and 13. Among a total of 81 skates, I found there were 25 male and 42 female *Raja stabuliforis*, 2 male and 3 female *R. scabrata*, 3 male and 2 female *R. erinacea*, and 2 male and 2 female *R. diaphanes*. These last-mentioned 2 females, measuring 751 and 763 mm. total length, each contained one egg capsule. None of the females of the other species, however, contained egg capsules.

Bigelow and Welsh (1925, Bull. U. S. Bur. Fish., 40 (1): 62) stated that the breeding habits of *R. diaphanes* in the Gulf of Maine have not been traced. Vladykov (1936, Le Nat. Can., 63: 211–231) declared that the breeding season of this species in Canadian Atlantic waters takes place in September. My observations indicate that during September this species also spawns in waters along the Maine coast.—LESLIE W. SCATTERGOOD, *U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.*

A NOTE ON THE SPAWNING BEHAVIOR OF *CARANX SEXFASCIATUS*.—A search of the literature has revealed not a single instance of reproductive behavior described for any carangid fish. Therefore the following evidently stands as the only data of this sort for the entire family.

A school of five horse-eye jacks (*Caranx sexfasciatus* Quoy and Gaimard) have been maintained at the Lerner Marine Laboratory in Bimini, Bahamas, for some time. They normally are occupied in circling their enclosure, 75 by 25 feet, in a loose school, as was illustrated by Breder (1949, Bull. Amer. Mus. Nat. Hist., 94 (2), Pl. 3, Fig. 3). On June 8, 1950, at 5:15 P.M., peculiar activity was noted. During this season the water temperature in these pens ranges from about 24° to 29° C. varying with each tidal period as they are alternately exposed to outflowing water from shallow flats, forming the Grand Bahama Banks, or to incoming water from the open ocean. At the time of the observations the water was just beginning to fall. The overcast sky and wind-induced roughness of the water made observations rather difficult.

Features of the activity which could be seen accurately follow. The two fish that were evidently attempting to spawn were ahead of the others which followed closely behind. The whole group was moving at higher than usual speed, giving the impression that the paired fish were attempting to get away from the rest. The two fish which were spawning or attempting to spawn speeded up their swimming as they drew together in a side to side position with their ventral surfaces in contact. In this act their attitude resembled to some extent that of centrarchids in spawning. Occasionally one of the pair reclined so far over as to be swimming in a horizontal position.

Further details were impossible to observe, except that at one time the pair had assumed a most unusual position. One of them, most likely the male, was pressing down on the back of the other with its side as though to force the latter into deeper water. In other words one fish was swimming in a normal vertical plane while the other was swimming above it in a horizontal plane with the mid-line of its body in contact with dorsal profile of the other. The significance of this is as yet unclear.

Not only, as already noted, are there no other data on the reproductive act in the Carangidae, but when such literature on the whole of the Scombriformes is examined, very little can be brought to light. For purposes of comparison, such that could be found is given herewith.

Scomber scombrus Linnaeus. Sars (1868, Ann. Mag. Nat. Hist., 4 ser., 2: 390) indicated that this species may be seen spawning at times in great numbers at the surface of the sea, and Steven and Corbin (1939, Rapp. Cons. Perm. Inter. Explor. Mer., 111: 15–18) showed that a few eggs were shed at a time, on a basis of ovarian examination. Cunningham (1889, Jour. Mar. Biol. Assoc. U. K., new ser., 1: 26) indicated that spawning was "approximately simultaneous" in a given locality, but Bigelow and Welsh (1925, Bull. U. S. Bur. Fish., 40, (1): 207) wrote that "Any given school spawns over a considerable period, the fish as caught being in various states—hard, running or spent."

Pneumatophorus diego (Ayres) on the other hand, according to Fry, (1936, Calif. Fish and Game, 22: 28) spawns away from the surface.

Thunnus thynnus (Linnaeus) when impounded in trap nets, according to Sella (1911, Mem. R. Comit. Talassogr. Ital., 2: 1–16), is said to have performed as follows. One individual, probably the male, has been noted to pass with a rapid twist under another, probably the female, rubbing venters with it. Heldt (1932, Rapp. Comm. Inter. Expl. Sci. Mer. Medit., 7: 203–318) reported a word-of-mouth account in a similar place which he is disposed to accept as follows. Two tunny would rise from deeper water to a depth of 4 or 5 fathoms and roll around touching their ventral surfaces together. At this moment the eggs and milt would be released. Then the fish would descend again and the whole act was seen to be repeated several times.

Although these data are much too fragmentary to be used as a basis of definite conclusion, it is to be noted that all the evidence herewith collected would tend to indicate individual pairing, while nothing in it would tend to support the idea of a communal reproductive act, so often casually attributed to schooling oceanic fishes.—CHARLES M. BREDER, JR., *American Museum of Natural History, New York 24, N. Y.*

NEW GULF OF MAINE RECORD FOR OCCURRENCE OF DOLPHIN, *CORYPHAENA HIPPURUS,* AND DATA ON SMALL SPECIMENS.—What is believed to be a new record for the occurrence of dolphin, *Coryphaena hippurus* (Linnaeus), in the Gulf of Maine, is herein recorded with the capture of one near Provincetown, Mass., on August 10, 1949. This fish was taken in a trap set by the Pond Village Cold Storage Company at North Truro, on the Massachusetts Bay side of Cape Cod. Collected by Mr. John Worthington, it was 435 millimeters long (fork length) and weighed 1 pound, 13 ounces.

Prior to 1949, I can find no recorded capture of dolphin in the Gulf of Maine, although there are at least two authenticated records of the occurrence of dolphin off Nova Scotia. (I am indebted to Dr. L. R. Day of the Fisheries Research Board of Canada for locating these Nova Scotia records).

In the summer of 1949, large numbers were taken off Martha's Vineyard (where occasional stragglers have been taken in other years), beginning on July 30 and 31, when Mr. Frank Mather and party, of the Woods Hole Oceanographic Institution, boated 25, the largest weighing 23 pounds. A northward continuation of this unusual distribution seems to account for the capture of the specimen near Provincetown, Mass., which is more than 50 miles farther to the north and lies inside of Cape Cod Bay. Their presence in these waters in 1949 was probably due to the very warm weather which apparently increased water temperatures in this area to limits tolerable to the species (Arnold, 1951 COPEIA (1): 87–88).

A recent paper by me (1951, COPEIA (1): 35–39) included the length-weight relationship of dolphin. However, when this relationship was computed, no data for small fish were available. During this unusual northern appearance I succeeded in collecting 23 small specimens, in cooperation with Mr. Frank Mather; the fork lengths in mm., followed by the weights (in pounds) in parentheses are 372 (1.06), 376 (1.06), 377 (1.00), 380 (1.12), 383 (1.12), 388 (1.00), 388 (1.19), 390 (1.38), 391 (1.12), 391 (1.25), 395 (1.25), 395 (1.38), 400 (1.19), 400 (1.25), 401 (1.44), 405 (1.44), 410 (1.56), 425 (1.56), 430 (1.62), 430 (1.69), 437 (1.69), 438 (1.69), and 455 (2.25).—HOWARD A. SCHUCK, *U. S. Fish and Wildlife Service, Woods Hole, Massachusetts.*

EASTERN BROOK TROUT EGGS TAKEN BY LONGNOSE SUCKERS IN BANFF NATIONAL PARK, CANADA.[1]—In view of the long-continued argument as to whether suckers will eat trout eggs, it is considered desirable to place on record a known instance where the eggs of eastern brook trout, *Salvelinus fontinalis,* were eaten by the longnose or northern sucker, *Catostomus catostomus.*

These observation were made on October 24, 1947, while catching brook trout for spawning purposes in the waters of the Seven Mile Beaver dams, a small body of water within the boundaries of Banff National Park, Alberta, Canada. A number of suckers, taken in the nets used to capture the trout, were killed, measured and the intestinal tracts examined for trout eggs. The sex, fork length and number of brook trout eggs in 9 northern suckers were recorded as follows:

Sex	Fork Length in Inches	Eggs in Intestinal Tract
Female	16	98
Male	16	95
Female	15	95
Male	15	92
Male	14	84
Female	14	82
Female	16	24
Male	14	9
Male	15	0

No attempt was made to identify the other materials found in the intestinal tracts of these specimens.

[1] Published by permission of the Controller, National Parks Bureau.

The spawning beds of the trout cover a very small area and are used by a large number of fish. Thus many of the redds of the early spawners are dug up by the late spawners and the eggs deposited earlier are exposed to the suckers. A close watch was kept on the suckers in this area and at no time were they observed to dig up trout redds, but they were seen to be feeding on what was presumed to be trout eggs, just below the redds. This can hardly be classed as wilful predation, but rather as a normal feeding habit. It should also be noted that the trout eggs which were eaten had been exposed to the light and other detrimental factors and thus would not have developed in a normal fashion.

These beaver dams contain only the two species of fishes. The brook trout were introduced by the hatchery and, for a number of years, this was the only species present. Since natural entry to these waters is not possible, it is believed that the northern suckers were introduced by anglers, who used them for bait and released them when the day's fishing was finished.—J. E. STENTON, *Banff National Park, Alberta, Canada.*

RECORD OF A WHITE-TIPPED SHARK, *CARCHARHINUS LONGIMANUS,* FROM THE NORTHWESTERN ATLANTIC.—A white-tipped shark, *Carcharhinus longimanus,* was caught from the U. S. Fish and Wildlife Service research vessel "Albatross III" on June 12, 1950, in the Gulf Stream at latitude 40°40.5′ N., longitude 57°01.5′ W., which is approximately east of New Jersey and south of Newfoundland. This specimen is noteworthy because of its place of capture, its stomach contents, and because it exhibits one previously uncertain morphological character.

Bigelow and Schroeder (1948, Fishes of the Western North Atlantic, Part 1 Sharks: 360–61) have shown that the species is evidently rare in the western Atlantic. Although they predicted it might occur off southern New England, the nearest record cited was for off Florida north of the Bahama Bank (seaward of the Gulf Stream). Our specimen was taken 700 miles farther north than this area. The identification was verified by Mr. Schroeder after the frozen specimen had been brought ashore.

The stomach of this shark contained a partly digested dolphin, *Coryphaena hippurus,* that had been bitten in half; no other recognizable food was found. Dolphin are exceedingly fast swimmers and have not been recorded previously as part of the diet of any of the Carcharhinidae, at least not in the memory of Mr. Schroeder. There is no evidence that the dolphin was captured while actively swimming. Its size (estimated at about 36 inches and about 14 pounds) is well below the maximum attained by this species, and thus old age might be ruled out. The dolphin might have been injured, diseased, or in some stage of sleep (if dolphin do sleep); or, on the other hand, it might have been in good health and actively swimming.

We trolled surface lines on this cruise and captured and saw a number of dolphin. It is interesting, however, that none was observed near where the shark was captured, nor anywhere east of longitude 63°W., although a considerable amount of trolling and watching for them was done in this area of the Gulf Stream.

Bigelow and Schroeder (*op. cit.*: 357) stated that embryos of *Carcharhinus longimanus* have ". . . a low dermal ridge occupying the middle 2/3 of the space between 1st and 2nd dorsals . . ." They were not sure that adults had this ridge as they wrote "We did not appreciate the importance of this character at the time when we examined the adults . . ." The adult specimen here recorded does have a distinct dermal ridge along the midline of the back but it occupies only about 1/3 of the space between the 1st and 2nd dorsals. This shark is a female, 199 cm. in overall length, and contained no young.—HOWARD A. SCHUCK AND JOHN R. CLARK, *U. S. Fish and Wildlife Service, Woods Hole, Massachusetts.*

A RECORD OF THE RARE FISH *LUVARUS IMPERIALIS* FROM OREGON.—On December 15, 1949, a specimen of the louvar, *Luvarus imperialis* Rafinesque, washed up on the beach inside Yaquina Bay at Newport, Oregon. The fish was found by Hollis Johnson and was given to the Newport Research Laboratory of the Oregon Fish Commission. Unfortunately the head region anterior to the eyes was missing, perhaps eaten by a seal, but the remainder of the fish was in good condition. The specimen was a female with an estimated standard length of 54 centimeters.

This is the first record of this rare though widespread species as far north as Oregon. The closest previously known locality (Ripley, 1948, Calif. Fish and Game, 34(1): 39–40) is off Crescent City, California, a distance of about 250 miles to the south. GEORGE Y. HARRY, *Department of Research, Fish Commission of Oregon, Astoria, Oregon.*

AN AQUARIUM EXPERIMENT ON THE AMERICAN EEL AS A PREDATOR ON LARVAL LAMPREYS.—The parasitic sea lamprey, *Petromyzon marinus,* has in recent years spread throughout Lakes Huron and Michigan and is now firmly established in these waters (Applegate, 1949, Mich. Cons., 18 (4): 13–15). Coincident with their spread, the abundance of lake trout, *Salvelinus namaycush,* has declined in both lakes (Hile, 1949, Trans. Amer. Fish. Soc., 76 (1946): 121–147)[1] and the lake trout as well as other species of fishes are showing an increase in scarring from lamprey attacks. For Lake Michigan the analysis of fishermen's questionnaires gave an increase in percentage by weight of lamprey-scarred lake trout from 31 percent in 1947 to 41 percent in 1948. The sea lamprey is now spreading through Lake Superior, the last of the Great Lakes containing a large population of lake trout.

Various methods to reduce the lamprey populations have been considered and are being tested. Among these is the possible introduction of a predatory species. From field observations along our Atlantic Coast the author regards the American eel, *Anguilla rostrata* (LeSueur), as a potential predator of the lamprey. In coastal streams and estuaries this fish is commonly found on muddy bottoms into which it burrows with ease. The eel generally spends its daylight hours buried in the mud with only its snout protruding, leaving its burrow most often at dark to feed. In feeding, the eel explores openings and crevices, and roots through the mud for its prey. The ammocoete of the sea lamprey also digs into the mud, but feeds by protruding its head slightly from its burrow and sifting the small organisms from the thin layer of water adjacent to the mud. Aquarium observations show that the eel is the more efficient burrower. In an aquarium having a coarse sand bottom the eel could bury itself immediately while the ammocoete struggled for some time before gaining entry. The possibility was therefore entertained that feeding eels attracted by the movement of the ammocoete would follow them into the mud and kill them.

In an experiment to test this hypothesis 4 inches of mud taken from typical ammocoete beds was placed in each of two identical aquaria of 45-gallon capacity. The mud was carefully searched for ammocoetes, and was free of them. On September 1, 1949, twenty-two ammocoetes of the American brook lamprey, *Entosphenus lamottei,* of the size ranges shown in Table I, were placed in each aquarium. The ammocoetes were anesthetized with ether before they were measured. Air was bubbled through both tanks and there was a slight circulation of water. Three eels, 219, 242, and 281 millimeters long, were placed in Tank 1 on September 2, 1949. Tightly fitting screens covered the tanks.

On September 20, a 165-millimeter ammocoete was found dead on the surface of the mud in Tank 1. Close examination showed a distinct notch located about 15 millimeters from the posterior end of the body. It has been noticed in aquaria that when the eel attempts to eat food too large to swallow, it seizes the food firmly and then vigorously rotates its body about its long axis in an effort to tear the food into smaller pieces. It is possible that the notch on the lamprey's body could be explained by this action. On September 23, a 150-millimeter ammocoete was found dead on the surface of the mud in Tank 1. Several places on the body were badly squeezed and showed large blood clots. These injuries could have been caused by the eel's mouthing the ammocoete. On September 23, three weeks after the introduction of the ammocoetes into the tanks, a count was made of the numbers remaining in each tank. The mud was carefully examined twice, a little at a time, in white enamel pans and all the ammocoetes removed. In Tank 1, containing the eels, 16 ammocoetes were recovered. In Tank 2, the control, which contained no eels, 21 ammocoetes were recovered. The mud was returned to each tank and the 16 remaining ammocoetes placed in Tank 1 together with the three eels, and the 21 remaining ammocoetes in Tank 2 under the same conditions as before.

On October 7, the 219-millimeter eel was observed outside its burrow nosing along the bottom. Suddenly a puff of dirt rose from one of the lamprey burrows. The eel quickly

[1] For Lake Huron only. The same condition is shown in unpublished data for Lake Michigan.

moved to this hole, searched it with its snout, and then rapidly burrowed in. Whether or not it caught the ammocoete is unknown, but there is strong indication that any slight activity of the larval lamprey will attract nearby eels. The experiment continued until October 14, 1949, six weeks after its initiation. During the entire experimental period no food was provided the eels other than the worms, insect larvae, and ammocoetes contained in the mud. At this time the aquaria were emptied and the mud examined as before. In Tank 1, containing the eels, only three ammocoetes were found. In Tank 2, without eels, 21 ammocoetes remained.

Undoubtedly the eels had destroyed a considerable number of the larval brook lampreys. How effective the eel will prove as a predator on the larval sea lamprey in nature is a matter for large-scale experimentation under natural conditions.

Factors that favor the use of the eel as a tool in reducing the populations of larval lampreys are: (1) eels may be caught readily in large quantities at a reasonable cost along our Atlantic Coast; (2) they are hardy fish and if kept moist can be transported great distances without water; (3) they will not reproduce in fresh water and therefore cannot be a permanent danger to the biological equilibrium of the Great Lakes; (4) they may possibly distribute themselves over a watershed containing lamprey larvae and thus eliminate the expense of individual attention to each of the larval beds; (5) they will be an active control factor for as many years as they live; and (6) the adult eel can be utilized as a food and game fish.

TABLE I

LENGTH FREQUENCY OF AMMOCOETES OF THE AMERICAN BROOK LAMPREY, USED IN AQUARIUM EXPERIMENTS TO TEST PREDATION BY THE EEL

Length of ammocoetes (millimeters)	Number of ammocoetes	
	Tank 1*	Tank 2†
30–39	1	1
40–49	1	1
50–59	.....	.....
60–69	1	.....
70–79	.....	1
80–89	1	1
90–99	1	2
100–109	4	3
110–119	.....	1
120–129	3	2
130–139	2	4
140–149	5	3
150–159	2	3
160–169	1	.....
Total	22	22

* Contained three eels, 219, 242, 281 mm. long.
† Control tank, no eels present.

Against the use of the eel is its possible predation upon other species of fishes. In the older, descriptive literature (Cheney, 1899, N. Y. Fish, Game and For. Comm. Rept. for 1898: 279–288; Jordan, 1905, A Guide to the Study of Fishes, 2: 147) the eel has been given a bad reputation as a fish predator. However, records of analyses of stomach contents in more recent literature (Bishop, 1936, Suppl. 25th Ann. Rept. N. Y. Cons. Dept. (1935): 122–139; Hartley, 1940, Freshwater Biol. Assoc. Br. Emp., Sci. Publ. No. 3; and Frost, 1945, *Ibid.*, 13th Ann. Rept.:9–13) indicate that the eel is omnivorous and that fish do not play as important a part in its diet as was formerly thought. The effect on other fishes should be thoroughly tested under natural conditions.

The Institute for Fisheries Research, Michigan Department of Conservation, provided space and other facilities for the conduct of this experiment. Staff members of the Institute supplied equipment for, and aided in, the collection of the ammocoetes of the brook lamprey.—ALFRED PERLMUTTER, *New York State Conservation Department, 65 W. Sunrise Highway, Freeport, L. I., New York.*

THE USE OF SEA CUCUMBERS IN POISONING FISHES.[1]—Substances of vegetable origin have been and are widely used in the tropics and subtropics of the world by native peoples for poisoning fishes. In the Pacific region the plants most commonly used are various species of *Derris* and the seeds of the tree *Barringtonia* (Merrill, 1943, U.S. War Dept. Tech. Manual, 10–420: v + 149 pp.). To a lesser extent *Tephrosia* and *Croton* are used. In other parts of the world other plants are used, such as *Mundulea* and *Euphorbia* in Africa (Raymond, 1939, Jour. Trop. Med. Hyg., 42: 295–303). The active ingredient in many of these native preparations is rotenone, which in concentrated form is one of our better insecticides and more recently has become used extensively in fisheries management in North America. (For a recent review see Krumholz, 1948, Jour. Wildlife Mgt., 12 (3): 305–17.)

The writer was not aware that animal fluids or products were ever employed in similar fashion to stupefy the fishes within a limited area. It was consequently a matter of great surprise and interest to discover sea cucumbers being used for this purpose on Guam.

During a minus tide early in the morning of November 26, 1945, five Guamanians were using sea cucumbers to poison fishes in several coral reef pools just south of the Ylig River. Prior to treating the pool, all possible exits were blocked with branches of the *Casuarina* tree. The common black sea cucumber of the region had previously been gathered in large numbers, and one of the men now began cutting these animals in two with a big knife. The other men wearing diving goggles squeezed the contents of the sea cucumbers into the various crevices and recesses of the pools. The natives claimed the "blood" was poisonous. Before long the water became noticeably turbid in appearance, and shortly thereafter fish began coming to the surface of the pool, exhibiting much the same type of behavior as in rotenone poisoning. At this time the fish were clubbed with long knives to immobilize them. The material from the sea cucumbers did not kill the fish, but apparently only made them weak and less active. Very few of the specimens did not resist capture, and all of them, even though inactive, still moved their opercula and occasionally made attempts to swim.

The writer and several other members of the NAMRU-2 staff were collecting coral reef fishes nearby at the same time with standard 5 percent rotenone powder. Our efforts were so much more effective than those of the Chamorros, probably because of the greater amount of poison used, that before long the natives deserted their pools and began collecting the surplus fish from ours.

Robert O. Smith, in making a survey of the fisheries of Micronesia in 1946 for the U. S. Commercial Company, observed a similar use of sea cucumbers on Majuro Island in the Marshalls (1947, U. S. Fish and Wildlife Serv., Fish. Leaflet 273: vi + 105 pp.). Here, however, the sea cucumbers were apparently pounded or pulped in the canoes and then dumped into the pools. In this rather extensive survey covering the Marshall, Caroline, and Mariana Islands, Smith did not observe or learn of any other localities where sea cucumbers were employed in this manner, although he called attention to a note in the *Guam Recorder* for May, 1941, reporting the long established use of sea cucumbers on Guam for collecting fish. No other records were found in the literature as to localities where this practice is carried on.

The writer is inclined to believe that the use of sea cucumbers in collecting fishes is relatively recent because of its restricted application and the scarcity of references to it in the literature. Ludwig (1889-1892, Bronn's Thier-Reich, Bd. II, Abt. 3, Buch I) does not record any uses of sea cucumbers other than for food.

Austin H. Clark (*in litt.*) wrote that a number of other persons have also mentioned to him within the past few years the use of sea cucumbers in the Pacific for poisoning fishes. The species involved is most likely *Holothuria atra* Jaeger.

The genus *Holothuria* is the largest genus of holothuroids, with more than 100 known species, approximately three-fourths of which occur in the Indopacific region. It is interesting that *Holothuria atra* is one of the several species that is virtually circumtropical, for it occurs in the Atlantic as well as the Indopacific. Moreover, this same species is one of ten collected and cured for human consumption in the southern

[1] Contribution No. 462 from the Department of Zoology, Indiana University.

Philippines, constituting one of the less desirable grades of trepang, known locally as "Tang Sim" (unpublished report of José S. Domantay).

Many echinoderms are noted for their toxic properties. Echinoids, in particular, may have poisonous pedicellariae as well as spines. The pedicellariae of *Strongylocentrotus dröbachiensis* and of *Toxopneustes pileolus* (Clark, 1950, Bull. Raffles Mus., 22: 53–67) are especially noteworthy in this respect. What the toxic principle might be in the holothurians used to capture fish life has apparently not yet been investigated.—DAVID G. FREY, *Department of Zoology, Indiana University, Bloomington, Indiana.*

MIGRATORY BEHAVIOR OF THE RAINWATER FISH, *LUCANIA PARVA*, IN THE YORK RIVER, VIRGINIA.[1]—On October 15, 1950, the writers observed migratory behavior of schools of the rainwater fish, *Lucania parva* (Baird and Girard), along the northern shore of the York River at Gloucester Point, Virginia. When first observed, at 15 minutes past noon, the fish were moving down-river (eastward) in spindle-shaped schools of about 400 individuals each, in water 8 to 10 inches deep. Throughout the observation period these schools moved at a rate of 40 feet per minute with intervals of 2 to 3 feet between schools. Each school was 6 to 8 feet long, 10 to 15 inches wide and contained 20 to 30 fish per linear foot. These schools continued to pass the Virginia Fisheries Laboratory until 4:00 PM. Estimates based upon the size of the schools, and the rate of their passing our observation point, indicate that more than 270,000 fish were involved in this mass movement. This tends to support the opinion advanced by Hildebrand and Schroeder (1927, Bull. U. S. Bur. Fish. 43 (1): 137) that the species could be an important food item for larger fish. The extent of this migration was not determined, but it was noted to continue over a three-quarter mile zone in front of the laboratory.

Hildebrand and Schroeder (*loc. cit.*) reported that this species travels in schools, often in association with *Gambusia* and *Fundulus*. We noted many variegated killifish, *Cyprinodon variegatus* Lacépède, and a few striped killifish, *Fundulus majalis* (Walbaum), among the schools of *Lucania*.—W. R. BECK, and W. H. MASSMANN, *Virginia Fisheries Laboratory, Gloucester Point, Virginia.*

[1] Contributions from the Virginia Fisheries Laboratory, No. 32.

Herpetological Notes

THE OCCURRENCE OF THE LOUISIANA NEWT IN IOWA.—The Louisiana newt (*Diemictylus viridescens louisianensis*) has not been reported as occurring in Iowa. In 1939, John Macdonald collected a specimen in a wet meadow south of Fairfield, Jefferson County, Iowa. The specimen is now in the herpetological collection of Parsons College, Fairfield. Mr. I. Lester Firschein has informed me of another specimen (Chicago Natural History Museum No. 37378) which was collected by R. A. Burton, 3 miles north of Olds, Washington County, Iowa, March 23, 1941. Neither specimen was measured but both, which I have examined, were adults with spotting and coloration as described by Bishop (1947, Handbook of Salamanders: 106–109). These two records extend the known range of the Louisiana newt westward into southeastern Iowa, although the subspecies is known to occur equally as far west in Minnesota and farther west in Missouri.—LOWELL S. MILLER, *Museum of Natural History, University of Illinois, Urbana, Illinois.*

THE EYES OF THE WORM LIZARD, AND NOTES ON THE HABITS OF THE SPECIES.—Recently Carr noted that newly hatched individuals of *Rhineura floridana* in Florida have eyes (1949, COPEIA: 77). I find that eyes are also present in some large adults. When present, they are much more evident in the living than in the preserved animal.

At hand are 14 preserved, adult specimens of *Rhineura*. Of these, ten seem eyeless; three have barely evident eyes; one has eyes which, although minute, are clearly visible. When this last specimen was alive, its eyes were evident as tiny blackish dots beneath a translucent skin. After two days in preservative, the eyes had become more conspicuous, standing out sharply against the pallid color of the head. After 20 days, however, the eyes were but very slightly darker than the head shields, and the overlying tissue had seemingly become more opaque. When the head was turned at various angles to the light, it was seen that the eye region was smoother and glossier than the bordering scales.

In this adult, the eye lies at the anterior tip of the lower primary temporal, in contact with the postocular, the "ocular," and the posterior loreal; it thus usurps the position which, in some eyeless examples, is filled by the subocular.

There is no correlation between total length and degree of eye development. The specimen with the best developed eyes is 311 mm. long, one of the largest in the series. Other eyed examples are 300, 270, and 207 mm. long. Eyeless individuals range from 257 to 330 mm. There is no difference between eyed and eyeless specimens in body scutellation, and no correlation between the occurrence of eyes and the provenience of the animal.

Eyed specimens of *Rhineura* were collected in rosemary scrub near Salt Springs, Marion County; in slash-pine and palmetto flatwoods near Gulf Hammock, Levy County; and in a well drained, lake-shore hammock bordering Bivin's Arm, near Gainesville, Alachua County. Eyeless worm lizards were found in the Bivin's Arm hammock; in turkey-oak woods at Silver Springs, Marion County; in live-oak hammock near Sumner, Levy County; in high pine near Lynne, Marion County; in slash-pine and wire-grass flatwoods near Lynne and near Sumner; and in broom-sedge fields near Ocala, Marion County. Mr. E. Ross Allen found a number of specimens under sod in a grassy field near Winter Haven, Polk County. An eyeless example is at hand from Green Cove Springs, Clay County, and another from Dover, Hillsborough County; habitat data are not available for these.

The literature contains little reference to the food of *Rhineura*. Mr. Allen informed me that captive examples, to his certain knowledge, ate earthworms, and lived for 13 months on that diet alone.

The specimens used in the present study were somewhat translucent; when they were held near a light, food in the digestive tract appeared as dark masses. These masses were removed and examined. A Marion County specimen contained about 0.1 cc. of fine sand and some organic material too macerated for identification. (Such stomach contents are commonly noted in forms that feed on earthworms.) A second Marion County specimen contained sand and a ball-like mass, about 2.5 mm. in diameter, of parasitic nematodes. The nematodes were, individually, almost too small to be seen without magnification. A third contained sand, unidentifiable matter, nematodes, and six fang-like terminal segments of spider chelicerae. The segments were identical in size and shape and were probably from a single species of spider of about 5 or 6 mm body length. A *Rhineura* from Gulf Hammock contained sand, nematodes, digested matter, and a chelicera segment which, from its shape and very large size, appeared to be that of a wolf-spider (*Lycosa* sp.). Two specimens from Bivin's Arm each contained sand, organic remains, and nematodes; one from Green Cove Springs contained an unusually large amount of macerated material, a few sand grains, the terminal portion of a large earthworm, five chelicerae segments believed to be those of wolf-spiders, several spider pedipalps, and a large, stout chelicera segment from an unidentified spider of considerable size (parasitic nematodes were lacking). All other stomachs appeared empty of food.

Apparently, *Rhineura* avoids hard and chitinous insects, preying instead on soft-

bodied earthworms and several species of spiders, all of which must frequently invade the lizards' tunnels.

In September, 1950, a hurricane struck the west coast of Florida. The accompanying rains lasted for several days, and flooded vast stretches of flatwoods near Cedar Key, Levy County. Collecting in the wake of the storm, Mr. Allen and I found two very large individuals of *Rhineura* floating dead in the water, apparently drowned.

The maximum length of *Rhineura* has been given as about 284 mm. (Smith, 1946, Handbook of Lizards: 434). However, larger specimens are recorded in the present paper. The largest worm lizard known to me was a Marion County specimen measuring 353 mm., or approximately 14 inches, in total length.—WILFRED T. NEILL, *Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida.*

NOTE ON OKLAHOMA SALAMANDERS.—While the writer and others have secured larvae of *Typhlotriton spelaeus* in a number of localities in the Oklahoma Ozarks, adult animals apparently have not been collected previously in the state. Mr. Robert Taylor brought in an adult collected May 21, 1950, in a cave located between Spavinaw and Jay, Delaware County, and a subsequent trip to the cave with Mr. Taylor, June 14, 1950, yielded additional specimens. No larvae were seen. The cave is larger and contains much more water than the one located 5 miles south of Kansas, Oklahoma, where the writer has frequently collected larvae of *T. spelaeus.* The cave was again visited in December, 1950, but despite careful search, and deeper penetration than on the previous trip, neither larval nor adult salamanders were seen. Two blind, white individuals of *Cambarus* were collected; the presence of such is perhaps indicative of an extensive underground drainage system.

A *Siren,* presumably *S. i. intermedia,* was collected from a deep pool in a small creek tributary to Jackfork Creek near Clayton, Pushmataha County, Oklahoma, March 29, 1948. The specimen subsequently escaped. This record extends the known range some 65 miles northwest from the coastal plain into the Ouachita physiographic province.

Some time ago (December 13, 1935) the writer collected a *Triturus viridescens louisianensis* (Amer. Mus. Nat. Hist., No. 52533) in a floodplain swamp 5 miles northeast of Tulsa. Since no subsequent newt records for Oklahoma extends the range this far west, the record seems worthy of publication at this late date.—ALBERT P. BLAIR, *Department of Zoology, University of Tulsa, Tulsa 4, Oklahoma.*

WINTER ACTIVITY IN OKLAHOMA FROGS.—The afternoon of November 23, 1950, was partly cloudy with strong variable winds and temperature in the fifties. A small hylid found jumping about near Gates Creek, Fort Towson, Choctaw County, Oklahoma, was found to be *Pseudacris n. triseriata.* This was noted as somewhat remarkable as I had never before seen *Pseudacris* at this time of year. That evening we made camp near Goodwater Creek between Goodwater and Cerrogordo, McCurtain County. While seining darters in Goodwater Creek, another *P. n. triseriata* was found, this time in the water. At dusk we heard the calls of three or four *P. n. triseriata,* in spite of the fact that the temperature was by now near the freezing point. About midnight a violent thunderstorm passed just south of us and we received a small amount of rain and sleet; by morning the temperature was around 20° F.

Shortly after seeing Rand's note (1950, COPEIA (4): 324) on leopard frogs in Indiana caves in winter, I was looking for salamanders (January 21, 1951) in and about the spring which marked the exit of a small stream from a tiny cave some 7 miles southeast of Locust Grove, Mayes County, Oklahoma. In the shallow spring and under adjacent limestone boulders which were more or less in the water were found approximately 20 individuals of *Rana pipiens* and 15 of *Acris crepitans,* all juveniles. They were moderately active and made some effort to escape when disturbed. The frogs must have made a considerable migration to this overwintering spot as the spring sinks into the ground and there are no pools of permanent water for some distance. Such an overwintering spot offers a very favorable situation with relatively warm water (approximately 50° F.) and relatively warm air temperature in the mouth of the small cave.—ALBERT P. BLAIR, *Department of Zoology, University of Tulsa, Tulsa 4, Oklahoma.*

THE MOST WIDELY HEARD AMPHIBIAN VOICE.—Identification by voice has long been recognized as an integral part of bird study, but those who have learned to identify amphibian calls still form a relatively small and select band of naturalists. Parenthetically, we may say that there is as much thrill in hearing the far-off nasal *quonk-quonk, quonk* of *Hyla andersoni* through the cedar swamps, or the rarely heard trill of *Bufo californicus* in a nearby arroyo, as there ever was in tracking down the call of the pileated woodpecker.

However, the mosquito-bitten trailers of amphibian songs have failed to note a most curious recent geographical extension of the range of one frog voice. Within the last twenty years, the call of one species of amphibian has become familiar to the ears of at least half the human race! I think this remarkable range extension to be worthy of herpetological attention.

Seated in a cinema theater in Stockholm, Bombay, Auckland, or a village in Mato Grosso, we watch the hero crawling through the snake-infested jungles of Borneo. It is dark, a tropic moon reflects on the river, and the night noises are heard distinctly. Suddenly we hear the sharp *rurrkk-uk, rurrkk-uk, rurrkk-uk* of the Pacific tree frog, our old friend *Hyla regilla,* and the whole illusion so carefully built up by Hollywood is shattered.

Fully half the night scenes in Hollywood sound movies, be the supposed setting Boston, Brazil, or Ujiji, bear the unmistakable voice of the commonest of California frogs. The average listener takes it for an insect song, and a herpetologist, if he were not familiar with Pacific Coast frog calls, might mistake it for the voice of the northern swamp tree frog, *Pseudacris n. triseriata* (Schmidt, 1948, Sci. Mo., 67:447). When we realize that over half the people alive today, in all continents, have seen (and heard) sound movies from California, we can easily see why the call of *Hyla regilla* is, in truth, the most widely heard amphibian voice.—GEORGE S. MYERS, *Natural History Museum, Stanford University, Stanford, California.*

ASIATIC GIANT SALAMANDER CAUGHT IN THE SACRAMENTO RIVER, AND AN EXOTIC SKINK NEAR SAN FRANCISCO.—As means of transportation and numbers of people grow, it is inevitable that strange animals and plants will be introduced, and collected, with increasing frequency. Records of these are sufficiently interesting to publish, even though, as in the present instances, the information is not too exact.

In 1939 or 1940, I received a message to the effect that a Sacramento River commercial fisherman had caught a "strange" animal which he had alive in his apartment. The animal was a fine *Megalobatrachus* (unquestionably identified generically by its closed gill openings), in perfect condition, alive in a wooden trough suspended in the bathtub, where I handled and examined it carefully for about 30 minutes. It was between 25 and 30 inches in length. Its captor said he found it in one of his catfish traps, set in the Sacramento River, "below Sacramento but above the delta." Probably this was not far from Walnut Grove.

Unfortunately, I was unable to make a specific identification, for the Chinese *M. davidianus* was not adequately differentiated from the Japanese *M. japonicus* in the literature then available to me. Moreover, the creature exhibited coloration quite at variance not only with that of the several live Japanese examples I have seen, but also with published accounts of the color of Chinese specimens. The dorsum was a uniform dark brown, with an irregular sparse sprinkling over all the back of rather well defined dull yellow spots, these spots being of irregular outline and about one centimeter in diameter. There were no small spots, darker than the ground-color, which is the common color-pattern of all the examples of *Megalobatrachus* I have seen, and the ground-color was definitely brownish, not slaty gray. Also, it must be emphasized that there was nothing to indicate that the coloration was due to disease. The animal appeared to be in the very best of condition.

The source of the specimen is, of course, unknown. Its strange coloration even suggested the possibility of a native Californian *Megalobatrachus,* which would not be zoogeographically surprising, but no other captures have been reported. Giant salamanders are said to be kept alive in temples in China and there are many Chinese in

California. Escape of such an example is a possible explanation. Several years before the incident (in 1936 or 1937) a San Francisco firm which dealt in live frogs for biological laboratories advertised receipt of a consignment of live giant salamanders but I did not see their stock. Finally, it is possible that the specimen was never in the Sacramento River and that the fisherman's story was made up out of whole cloth. Certainly the muddy lower Sacramento is unlike the clear running water frequented by *Megalobatrachus,* but I see no reason why one of these animals could not survive in the Sacramento. Besides, circumstantial evidence pointed strongly to the truth of the fisherman's story.

Quite as strange was another such capture made while I was a student at Stanford, in 1930. The late Prof. James I. MacMurphy of the Botany Department, brought me a quite unexpected skink of large size (nearly 1 foot) and probable Australian affinity, caught the day before with his neighbor's help on a hill in the western outskirts of the town of San Mateo. The beast had a blue tongue, but was considerably rougher in squamation and duller in color than the common *Tiliqua scincoides,* with which I was familiar. However, it did not have the very rough scales and short tail of *Trachysaurus rugosus.* With my rudimentary knowledge of Australian herpetology, and Boulenger's "Catalogue of Lizards," the beast was identified as being close to the genus *Tiliqua.* As I was shortly to leave on a trip, I took the skink to the Steinhart Aquarium to be kept alive, and asked that it be given to Mr. J. R. Slevin, herpetologist of the California Academy, if it died. Upon my return, the animal had died and somebody had thrown it out, together with all hope of carefully identifying it. Prof. MacMurphy's neighbor told him that he had previously killed a lizard of the same size and kind as the one they later caught alive. Where the animals came from is unanswered. No others have been reported.—GEORGE S. MYERS, *Natural History Museum, Stanford University, Stanford, California.*

THE NUMBER OF YOUNG FOUND IN THE ISLAND NIGHT LIZARD.—During the course of experimental work, two gravid females of *Xantusia riversiana* Cope from a group collected on San Nicolas Island, California, in early September of 1950 were kept in the laboratory. After the birth of one young, which appeared normal in every respect, the parent lizard was sacrificed in an attempt to deliver any further offspring by surgical intervention. This procedure, part of a currently conducted research program, has been successful with many individuals of *X. vigilis.*

Two foetuses were found inside the parent, coiled up within their enveloping membranes, with their tails rolled under the gular areas. Even though these two additional young appeared to be at term, being as fully developed as their living sibling, they did not survive delivery. The snout-vent length of the normally delivered young was 33 mm., and the snout–vent lengths of the other two were 30 and 33 mm.

Surgery on the other gravid *X. riversiana* revealed four foetuses which, however, were still immature. They showed reflex convulsive movements when they were removed from the enveloping membranes, but since their integument apparently was not fully developed they suffered extensive water loss and did not survive. Their snout–vent lengths ranged from 25 to 27 mm.

These findings in *X. riversiana* are in marked contrast to the well-established fact that *X. vigilis* produces only one or two young per year (Cowles, 1944, COPEIA (2): 98–100; Miller, 1948, Univ. California Pub. Zool., 47: 197–224; Smith, 1946, Handbook of lizards). *Xantusia henshawi* is known to have one or two offspring each year; this was reported by Klauber (1926, COPEIA (152): 115–117) and was observed in our laboratory this September (1950) where one gravid *X. henshawi* isolated in a cage gave normal birth to two healthy young. Klauber (1931, Trans. San Diego Soc. Nat. Hist., 7(1): 1–16) also reported that *X. arizonae* gives birth to only one or two young.

Since both of the specimens of *X. riversiana* examined did produce more than two offspring, it would appear that the observed increase in number of siblings per female in this species of *Xantusia* over that in the three other species from the southwestern United States is not an anomaly. However, further data are necessary before definite conclusions can be drawn.—YOST U. AMREIN and MARGARET B. AMREIN, *Department of Zoology, University of California, Los Angeles, California.*

OVARIAN EGG COMPLEMENTS IN THE SALAMANDER *EURYCEA BISLINEATA RIVICOLA* MITTLEMAN.—The number of eggs deposited in groups in the field has been reported as variable for *Eurycea bislineata bislineata* (Green) by Wilder (1924, COPEIA, 133: 77–8), Bishop (1941, N. Y. State Mus. Bull., 324: 282), and Wood (1950, Proc. Va. Jour. Sci., 1 (4): 348). The number of eggs deposited in the laboratory by artificially stimulated females has also been reported as variable by Noble and Richards (1932, Amer. Mus. Nov., 513: 1). Since Wilder (1924) has reported the number of eggs deposited in the field to be consistent with the number of large ova found in gravid females from the same region, it would be expected that the number of large ova in gravid females should be variable. To determine the limits of this variation, and the extent of correlation between the size of the females and their ovum complements, the authors dissected the ovaries of 102 gravid specimens of *Eurycea bislineata rivicola* Mittleman from southwestern Ohio. Large ova were counted, and snout-vent measurements were taken.

The specimens studied were collected between mid-November and mid-April (85 percent in January and February). Ovaries contained large yolk-filled ova (1.5 to 2.5 mm. in diameter) and small white ova (0.3 to 0.75 mm. in diameter). Intermediates between these two size-groups of ova were not noted, and only large ova were counted. The snout-vent measurements were based on the straight-line distance from the anterior tip of the snout to the inner posterior margin of the cloaca. Length measurements were plotted against ova counts (Fig. 1).

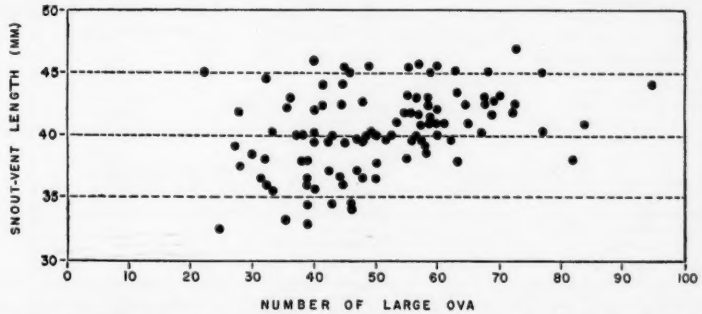

Fig. 1. The relation of large ovum complements to snout-vent length in 102 specimens of *Eurycea bislineata rivicola* Mittleman.

The numbers of large ova per female ranged from 22 to 95. The averages of the 5-mm. size-classes ranged from 35 ova in the smallest size-class to 57 in the largest. Gravid females of any length may have the minimum ovum complements of between 20 and 30, but only the larger specimens are frequently found to have over 50.

A series of 38 specimens was studied to determine the extent of any unilateral tendencies in the distribution of ova in the ovaries. In three females both ovaries contained the same number of large ova. In one specimen there were 25 ova in the left ovary, none in the right. In the remaining 34 specimens the complements were unequal, the average difference between the ovaries in number of large ova being five, the maximum difference being ten. Averages based on 38 specimens showed no tendency for either ovary to predominate in the numbers of large ova.

The correlation between snout-vent length and number of large ova was evaluated by the product-moment method. It was found that $r = 0.462$, $t = 5.191$, indicating that the probability is considerably less than one in a hundred that these data do not demonstrate a significant correlation.

The authors gratefully acknowledge the field assistance of D. E. Ladd, M. E. Fitzmaurice, R. R. Knotts, and A. E. Verwyst.—JOHN THORNTON WOOD, *Department of Biology, College of William and Mary, Williamsburg, Virginia,* and WILLIAM EDWARD DUELLMAN, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

LONGEVITY OF SNAKES IN CAPTIVITY IN THE UNITED STATES.—This list contains what records are available to us. We would like to hear from anyone having better records, or ten-year records of other species. We intend to bring the list up to date each year as of the first of January. Only the oldest snake of each species or subspecies is listed. An asterisk indicates that the specimen was alive on January 1, 1951.

Species	Location	Years	Months
**Agkistrodon contortrix laticinctus*	San Diego Zoo	10	7
**Agkistrodon contortrix mokeson*	San Diego Zoo	14	6
**Agkistrodon piscivorus*	R. M. Stabler	15	8
Boa annulata	Phila. Zoo	12	4
**Boa enydris cooki*	San Diego Zoo	11	8
Boiga dendrophila	St. Louis Zoo	11	9
Constrictor constrictor constrictor	Phila. Zoo	12	3
**Constrictor constrictor imperator*	San Diego Zoo	13	3
Crotalus adamanteus	No. Carolina St. Mus.	14	9
**Crotalus atrox*	San Diego Zoo	14	7
Crotalus basiliscus basiliscus	San Diego Zoo	10	1
**Crotalus durissus unicolor*	San Diego Zoo	10	5
**Crotalus horridus horridus*	San Diego Zoo	13	7
**Crotalus mitchelli pyrrhus*	San Diego Zoo	11	1
Crotalus ruber ruber	San Diego Zoo	12	3
**Crotalus tortugensis*	San Diego Zoo	13	9
**Crotalus viridis helleri*	San Diego Zoo	13	10
**Crotalus viridis viridis*	San Diego Zoo	12	1
Drymarchon corais couperi	Robert Riggs	12	11
Dendroaspis viridis	St. Louis Zoo	11	3
**Elaphe guttata guttata*	Phila. Zoo	21	4
**Elaphe obsoleta obsoleta*	Amer. Mus. Nat. Hist.	13	6
**Elaphe obsoleta quadrivittata*	San Diego Zoo	13	7
**Epicrates angulifer*	San Diego Zoo	12	2
**Epicrates cenchria crassus*	Staten Island Zoo	13	2
Epicrates cenchria maurus	Bronx Zoo	27	4
Epicrates striatus	Phila. Zoo	16	0
Eunectes barbouri	Phila. Zoo	13	11
Eunectes deschauenseei	Phila. Zoo	13	10
Eunectes murina	Washington Zoo	28	0
Helicops schistosus	Phila. Zoo	12	3
**Lampropeltis doliata amaura*	Geo. P. Meade	14	7
**Lampropeltis doliata annulata*	San Diego Zoo	10	5
Lampropeltis getulus brooksi	San Diego Zoo	10	0
**Lampropeltis getulus californiae*	San Diego Zoo	14	1
**Lampropeltis zonata multicincta*	San Diego Zoo	11	4
Lichanura roseofusca roseofusca	San Diego Zoo	12	0
Masticophis flagellum piceus (black)	San Diego Zoo	11	2
Masticophis flagellum piceus (red)	San Diego Zoo	12	2
Masticophis flagellum testaceus	San Diego Zoo	13	5
**Naja melanoleuca*	San Diego Zoo	22	3
Naja naja	Phila. Zoo	12	4
Naja naja atra	Brookfield Zoo	10	3
**Naja nigricollis*	Brookfield Zoo	16	2
**Naja nivea*	San Diego Zoo	13	11
Ophiophagus hannah	Grace O. Wiley	11	10
**Pituophis catenifer affinis*	San Diego Zoo	10	8
**Pituophis catenifer annectens*	San Diego Zoo	14	4
Pituophis catenifer catenifer	San Diego Zoo	11	0
**Pituophis melanoleucus melanoleucus*	San Diego Zoo	10	5
**Python curtus curtus*	St. Louis Zoo	17	5
Python molurus bivittatus	Phila. Zoo	14	11
Python molurus molurus	Phila. Zoo	13	0
Python reticulatus	St. Louis Zoo	20	0
**Python sebae*	Phila. Zoo	14	1
Sistrurus catenatus	Tabor College	14	0
Ungaliophis guatemalensis	Grace O. Wiley	17	8

C. B. Perkins, *Zoological Society of San Diego, San Diego, California.*

THE WOODFROG IN GEORGIA.—*Rana sylvatica sylvatica* LeConte has not been previously recorded from the state of Georgia. The nearest and most southerly records are from northern South Carolina. Cope (1889, Bull. U. S. Nat. Mus., 34: 450) lists one from Miss Charlotte Paine of Anderson, Anderson County; and Chamberlain (1939, Charleston Mus. Leaf., 12: 33) lists it from Greenville County, and Rocky Bottom, Pickens County.

An adult female was taken October 28, 1950, by Frank Durant, a student at the University of Georgia. The specimen was found at the Mill Creek Trout Rearing Station, Blue Ridge Game Management Area, Chattahoochee National Forest. This locality is in Fannin County, approximately 12 miles north of Dahlonega, at the southern edge of the Blue Ridge Mountains in an area of Oak-Hickory and White Pine-Eastern Hemlock associations at an elevation of 2250 feet.

The frog, which was swimming in a concrete trout rearing pool at the time of capture, was typical in coloration, structure, and general appearance as outlined by Wright and Wright (1949, Handbook of Frogs and Toads : 540). Its snout-to-vent measurement was 64 mm.; femur, 40 mm.; tibia, 43 mm.; tarsus, 20 mm. The body was distended with well developed eggs.

This record extends the previously known range approximately 150 miles south and west and indicates a distribution in the Georgia Appalachians similar to that of *Desmognathus ochrophaeus, D. phoca* and *D. quadramaculatus*. However, there is a possibility that this individual was introduced with trout fry, considering the situation in which it was found. But this possibility is very remote since most of the trout reared at the station are hatched close by in Georgia.—Robert L. Humphries, *Department of Biology, University of Georgia, Athens, Georgia.*

Reviews and Comments

FISHES OF MAINE. By W. Harry Everhart. Maine Dept. Inland Fish. and Game, Augusta, Maine, 53 pp., 65 line drawings, 8 col. pls., 1 col. frontis., 1950. $1.00.—The freshwater fish fauna of Maine is a meager one in number of forms. Only 49 species, distributed among 20 families (10 of which are monotypic), are listed in *Fishes of Maine*. Eight of these have been introduced by man. If we include as freshwater fishes those species that penetrate fresh water, then *Fundulus heteroclitus* and *Apeltes quadracus* should be added to Everhart's list. This would bring to 43 the known number of native freshwater fishes in Maine. The present booklet was written for the fishermen of Maine, to aid them in identifying the fishes they catch and observe, but it will be referred to by layman and scientist as well. It is essentially a compilation, with keys much simplified from those used in the "Fishes of the Great Lakes Region" by Hubbs and Lagler. The account is prefaced by some brief notes on fishes, followed by instructions for identification, with a key to the families next in order. Keys to species within families, where necessary, precede brief remarks on distribution, habitat, and life history of each species except for the minnows and sticklebacks, which are each treated collectively. It is gratifying to note that the common names employed are those officially adopted by the American Fisheries Society. An index to scientific and common names completes the booklet.

Most of the color plates are reasonably good and were based upon living fish; those of the brown trout, lake trout and blueback trout are the best. Unfortunately no live Sunapee trout could be obtained and the color plate of that species is poor. Frequent absence of basic punctuation detracts from the readability of the text. A few errors have crept in. For example, the opercle is mislabelled operculum on the first drawing; the king salmon has 15 to 19, not 19 to 29, anal rays; and the sense of

smell is stated to be probably the most acutely developed sense in fishes. The quality of the numerous line drawings is so poor that even a person familiar with the fishes of Maine would experience difficulty recognizing many species. Lack of accuracy in these drawings has greatly reduced the value of the brief keys. Such unnecessary carelessness is inexcusable. The publication is otherwise nicely printed in an ample format (approximately 8 x 10 inches). A drainage map of Maine would have been a useful addition.

The need for accurate, popular books on the fishes of many of our States has been a critical one for many years. The appearance of such publications is still far behind the demand for them. When carefully prepared, such books provide a marvelous opportunity not only to inform the fisherman and interested layman of what he catches and sees but, what is more fundamental, to stimulate youngsters to enjoy and appreciate the natural resources of their State. Young people, especially, deserve high quality work and it is hoped that *Fishes of Maine* will be greatly improved by a revised edition.—ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

EDITORIAL NOTES AND NEWS

According to a letter from PROFESSOR OTA OLIVA, DR. KAREL SCHÄFERNA, first Professor of Hydrobiology and Ichthyology of Charles University, Prague-Czechoslovakia, died on December 28, 1950. From 1934 until his death, PROFESSOR SCHÄFERNA was Director of the Department of Hydrobiology and Ichthyology and Czechoslovakian representative on the "International Association of Theoretical and Applied Limnology."

University of Florida

CURRENT graduate work on the cold-blooded vertebrates in progress in the Department of Biology includes: FISH.—WILLIAM M. MCLANE, distribution of the fishes of the St. Johns River drainage (doctoral problem), and *Ameiurus natalis* in subterranean waters of Florida. GEORGE K. REID, Jr., bayfishes of the Cedar Keys Area (doctoral problem). R. KIRK STRAWN, an ecological study of the seashores of the Cedar Keys Area (master's). AMPHIBIANS.—JOHN D. DECKER, the chromosome number and morphology of the Sirenidae (master's). JAMES C. KNEPTON, a study of the use of native frogs in the diagnosis of early pregnancy (master's). JOHN S. MECHAM, the bionomics of *Rana clamitans* (master's). REPTILES.—JOHN W. CRENSHAW, an ecological study of the water-dwelling reptiles of a north-central Florida region (doctoral). EDWIN H. MCCONKEY, a systematic study of the genus *Ophisaurus* (doctoral), and studies on the *Eumeces egregius-onocrepis* complex. DR. COLEMAN J. GOIN has been granted a Department of Biology fellowship enabling him to spend part of the summer at Mountain Lake Biological Station.

News Notes

ROBERT H. KANAZAWA has accepted the position of Museum Aide in the Division of Fishes, U. S. National Museum, effective February 15, 1951. MR. KANAZAWA formerly worked in the Division of Fishes, Chicago Natural History Museum.

DR. LARS GABRIEL ANDERSSON, of Lidingo, Sweden, died February 13, 1951, at the age of 83. DR. ANDERSSON died suddenly after a full day's work at the Riksmuseum in Stockholm, according to a letter recently received from his daughter.

P. MAEDER, of Basilisk, Blauensteinerstr. 10, Basle, Switzerland again writes of their continued interest in purchasing living specimens of American reptiles, including a considerable variety of lizards, turtles and snakes. Persons who are interested should write to MAEDER.

WILFRED T. NEILL, of Ross Allen's Reptile Institute, has begun a study of the taxonomy and natural history of the rainbow snake, *Abastor erythrogrammus.*

Word has just been received of the death of DR. SHERMAN C. BISHOP, on May 28.

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